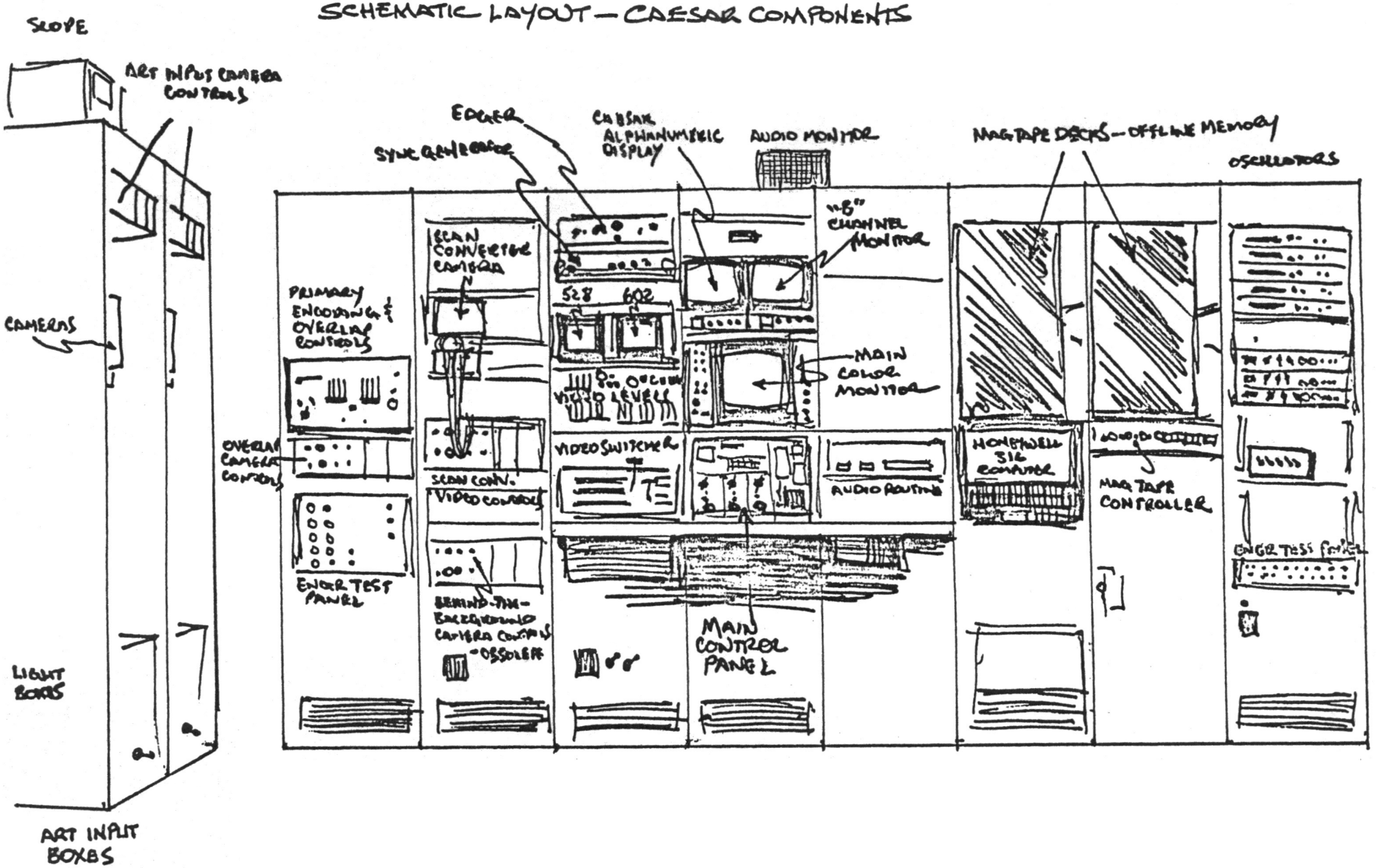
CAESAR

SCHEMATIC LAYOUT — CAESAR COMPONENTS



~~Cal Sawyer~~

CAESAR

CAESAR is the name of an electronic animation system that utilizes digital computer, analog computer and television technology. These technologies are combined in a unique manner so that an artist or an animator can use the power of a hybrid computer in combination with his artistic talents to produce animation. An artist can use his drawing skill to create the characters and then his sense of motion to direct the character's movement.

CAESAR animation is based on the concept of mapping surfaces. The operation of a television broadcasting system is also based on mapping surfaces. The surface of the target on the image tube in the camera is mapped onto the surface of the Cathode Ray Tube (CRT), in the receiver. In the case of television the desirable mapping function is unity, that is, the two surfaces are identical. Then the image on the receiver is a faithful reproduction of the image picked up by the camera. Sometimes due to problems in the receiver or interference with the broadcast signal the mapping function is different from unity. Then the television image appears torn, it appears to roll or it looks distorted. The scene in front of the camera has not changed but the image on the television receiver has changed due to the change in the mapping function.

CAESAR produces animation by mapping the input artwork onto an output plane whose shape is precisely controlled. The image plane can be divided into as many as 8 different sections. Each section encompasses a horizontal slice of the input artwork. Viewed on the output plane, each section can have an arbitrary shape, orientation and position. These characteristics are controlled by the operator specifying about 20 different parameters for each section. The parameters are horizontal and vertical size; horizontal and vertical axis rotation; frequency, phase and amplitude of the section shaping function; rotation, horizontal and vertical position; depth and finally an overall horizontal and vertical position that affects all 8 sections.

Let us define a character as any object to be animated that has multiple moving parts. It can be a Donald Duck, a trapeze artist or a graphic symbol. An artist wishing to animate a character with the CAESAR system first must draw the character as it appears in each scene. From this the input artwork is prepared drawing each portion of the character that must move independently on a separate section. For example if the character is a man that will be animated to walk then the input artwork would probably have his body, head, front leg, back leg, front arm and back arm on separate sections. Several examples of an input artwork configuration and the types of output images that can be produced are demonstrated.

Graphic symbols such as company logotypes and objects like automobiles or buildings can also be manipulated or animated. The important factor to remember is that each portion of the image that is to move independently must be located on a separate section of the input artwork. This means that 8 independent image components can be controlled by the animator.

Many different kinds of artwork manipulations are possible with the CAESAR system. Manipulations that can be applied to each section individually shall be described first. Perhaps the simplest operation is that of translation. Each section can be moved to any location on screen or off. Size can be changed by varying horizontal size and vertical size, either independently or both together. The attitude of each section can be controlled by the rotation parameter. Each section can be positioned at any angle in 0.7 degree steps. Also controllable is the center of rotation, that point about which the section rotates. Horizontal axis and vertical axis parameters can position the center of rotation to be any point on the section or to most points off.

The ability to control the shape of the output plane is very important. As many as two bends can be arbitrarily positioned with their amplitudes independently controllable. Other shapes, too numerous to describe in detail, are possible. All of the shaping effects are controlled by the

operator selecting the waveform, frequency, phase and amplitude of the shaping function generator that best produce the desired image.

Multiple views of the same element can be located side by side on a section. All of the views except one can be blanked and the one to be unblanked can be changed at completely controllable increments of time. Therefore, faces containing different expressions or numbers that need to change can be drawn on the same section and only the desired one is used to produce the output image.

There is a feature called "overlap" that keeps elements of a character that are located behind other elements from showing through them. Therefore an arm of a character can pass in front of its face and the arm will obscure the face. Which element is nearer the viewing plane than another is controlled by positioning of the input artwork.

Colors are also controlled by the operator. Areas that are a certain shade of grey can be transformed to an arbitrary color at the output plane. There may be as many as four different colors on a character plus one other color for the background of an image. All of these colors can be made to change during a scene. Any image existing as a color television signal can be substituted for the background color. As an example, the signal could come from a color television camera that is viewing a piece of color artwork.

It is possible to produce a wide variety of output images from the one piece of input artwork by selecting appropriate values for all of the animation parameters for each section. These parameters are either selected by the operator or calculated by the computer in the animation procedure. The operator adjusts the parameters to produce the desired "key" frames. He also selects the number of frames between each key frame which controlls the timing of the animation. Then the digital computer portion of CAESAR calculates the parameters for each of the "in between" frames according to the selected fairing function.

Parameter values are controlled by the operator pushing the appropriate push buttons to select the parameter and then rotating a knob to adjust the parameter's value. The operator uses visual feedback, which is available since response is instantaneous, to decide what parameter value is best. One knob can control any of the parameters, but three identical knobs are available so that three different parameters' values can be varied simultaneously. Thus it is possible to try various combinations of related parameters' values to help choose those that produce the desired effect.

Two different types of artwork are used by CAESAR. If the background is to consist of a full color scene, then that full color scene must be supplied. A color camera converts the color artwork to a television signal and it can then be combined with the animated character.

The artwork for the character to be animated is contained on a piece of film containing up to five different areas. Each area that is to be a different color is coded by having a different level of light transmittance. This artwork is backlighted and then has the appearance of being black, clear and three shades of grey. The greys are produced by adding the appropriate type of Letrofilm to clear areas. Examples of input artwork are shown.

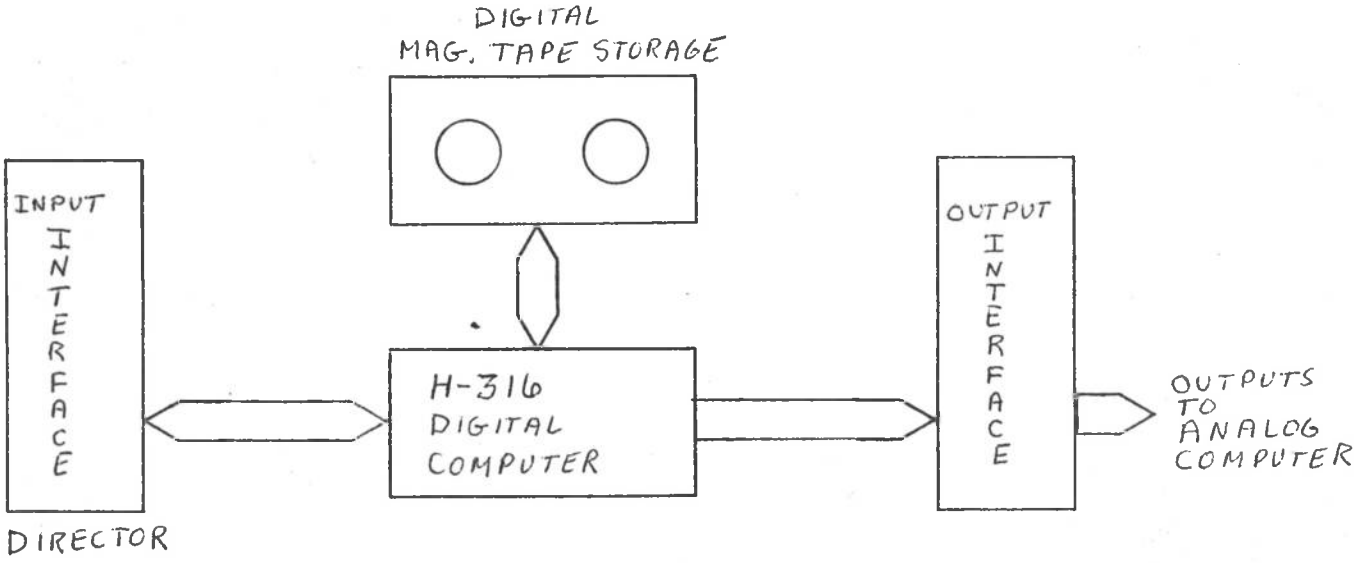
Cal Sawyer

H-316 INPUT-OUTPUT TECHNIQUES USED IN THE CAESAR SYSTEM

General Information

The digital computer's role in the CAESAR System is to assimilate, store, retrieve, and distribute data (analog and digital) to the analog computer portion of the system.

These functions may be conveniently broken up into four areas:



The H-316 will communicate with the artist via the director. The role of the director will be that of allowing the artist to create, edit and play back animated sequences, prior to storage on film or video tape, eliminating more expensive and time consuming editing techniques. A more detailed description of the director will occur at a later date.

The H-316 will act more as a controller rather than as a computer, in the general sense of the word. In fact, the computations required of the CAESAR System must occur in "real-time" and are more efficiently

handled by existing analog computer techniques.

If, through experience, it is found that the computational powers of the H-316 can be effectively used, they will be incorporated into the system, however at the present time the computations will be held to a minimum.

Digital computer programs (software) will initially be constructed to allow as much artist control as possible.

The H-316 must store information or parameters on digital magnetic tape and present this information to the output interface. Information updates will occur at 24 or 30 updates or frames per second (film or T.V. rates).

Each frame will consist of from 45 to 225 computer "words" of information, depending upon the number of "sections" occurring within a frame. These computer words will be transfered to their respective output interface channels at the proper rate.

The output channel may be digital (true/false-on/off) for switching video sources, blanking of the video, controlling an animation oscillator, etc., or it may be a digital to analog converter which will convert the magnitude of the computer word to a specific voltage which will be used by the central processor unit (CPU)--analog computer--as information for making a computation.

H-316 Output Interface Description

Each of the 45 output channels (list 1) is updated via the data multiplex control (DMC) feature of the H-316.

The DMC allows a block of data to be transfered at high speed

(3.2us/word maximum) between core memory and an output buss with little or no software direction except possibly for initiating this action and sensing the completion of the transfer. During a transfer, any computations taking place in the H-316 are interrupted.

Utilizing existing synchronization signals (vertical reset and horizontal reset) the hardware is designed to be completely automatic.

Signals are generated to inform the controlling program that a new update is required. It is then up to the program to direct the DMC to a different portion of core memory or modify the existing locations with the new information prior to the next automatic block data transfer.

The DMC in our H-316 has 8 channels arranged on a priority basis. Channel 1 has highest priority. A higher priority channel can interrupt the data transfer of a lower priority channel.

Associated with each channel are two reserved adjacent memory locations. The first contains the starting core location (M1) to be used in the data transfer and the second contains the final core location (M2).

Transfers may be made to or from core memory. This description will be limited to a data transfer from core memory to the output interface.

DMC Channels:

1. Digital Mag Tape
2. Digital Mag Tape
3. Output Interface
4. Input Interface
5. Alpha-Numeric Display

6-8. Unused

After the DMC mode is entered and M2 is reached, a signal called end of range (EOR) is generated for control purposes and fed to the hardware. If EOR occurs and then a new data transfer request occurs, the next transfer will again be from M1 through M2, providing M1 or M2 were not changed by the software.

With this information, the output interface can now be described.

We presently have 45 separate output channels (list 1).

Since the H-316 can only update one channel at a time and the remainder of the CAESAR System requires a parallel update, double buffering of the digital outputs are required. The serial by channel, H-316 update to buffer 1 is controlled by a channel address counter (figure 1).

The parallel update between buffer 1 and buffer 2 occurs on the vertical reset and section change pulses.

The channel address counter may be reset to zero and preset to a specific channel number. It is incremented after each transfer from the H-316 occurs. A control signal is generated when the last channel is updated.

Assume that a frame consisting of 3 sections is to be displayed at T.V. rates. Due to the interlaced scan, two fields of 16.6 ms each are required to completely display one frame of information. This means for output channels which remain the same for the entire frame (grey levels), their respective buffer 1 updates need only occur once per frame. They are actually updated on each field with the same information in field 1 and field 2. For output channels which must change with a section change, their buffer 1 updates must change 3 times per field, however section 1,

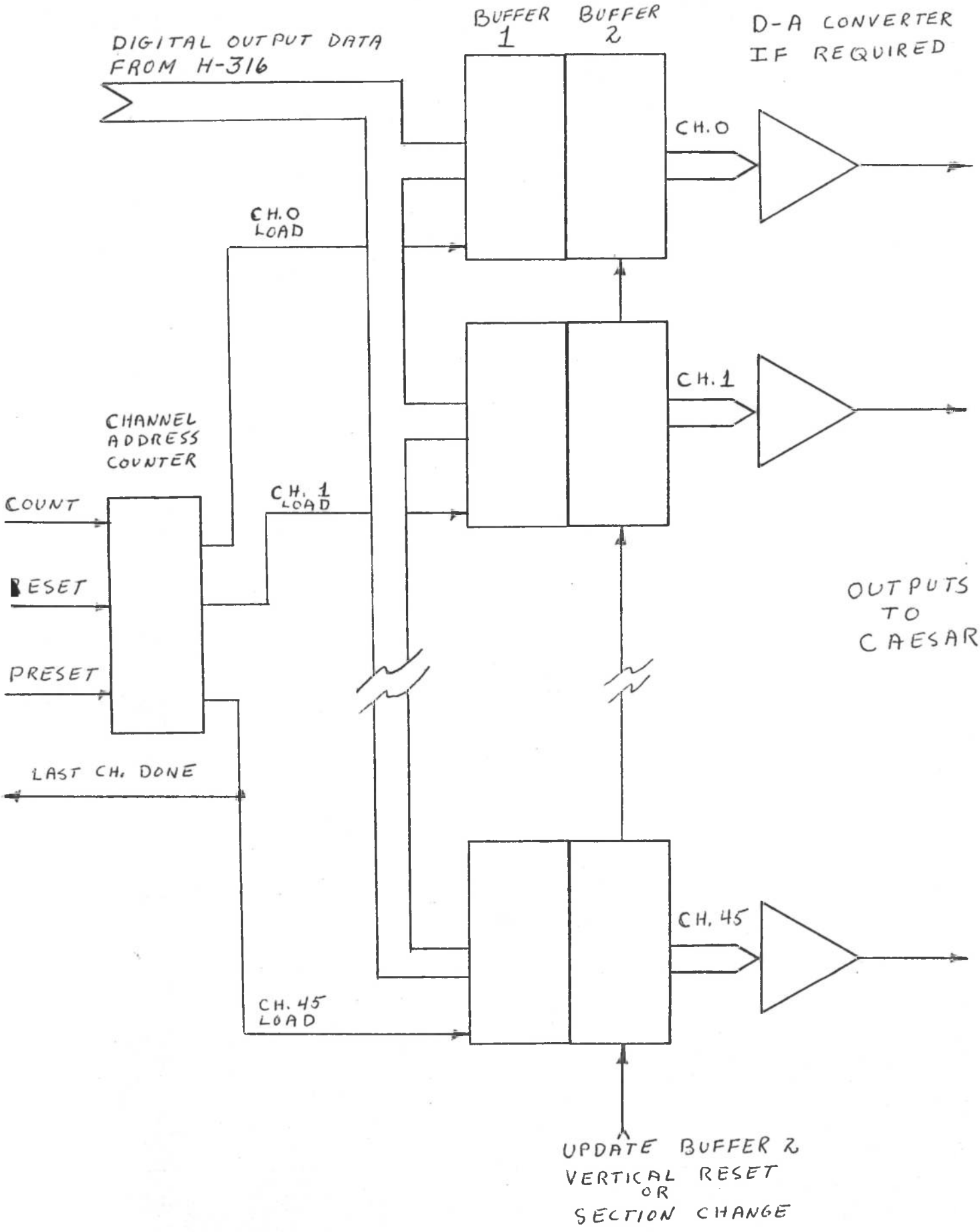
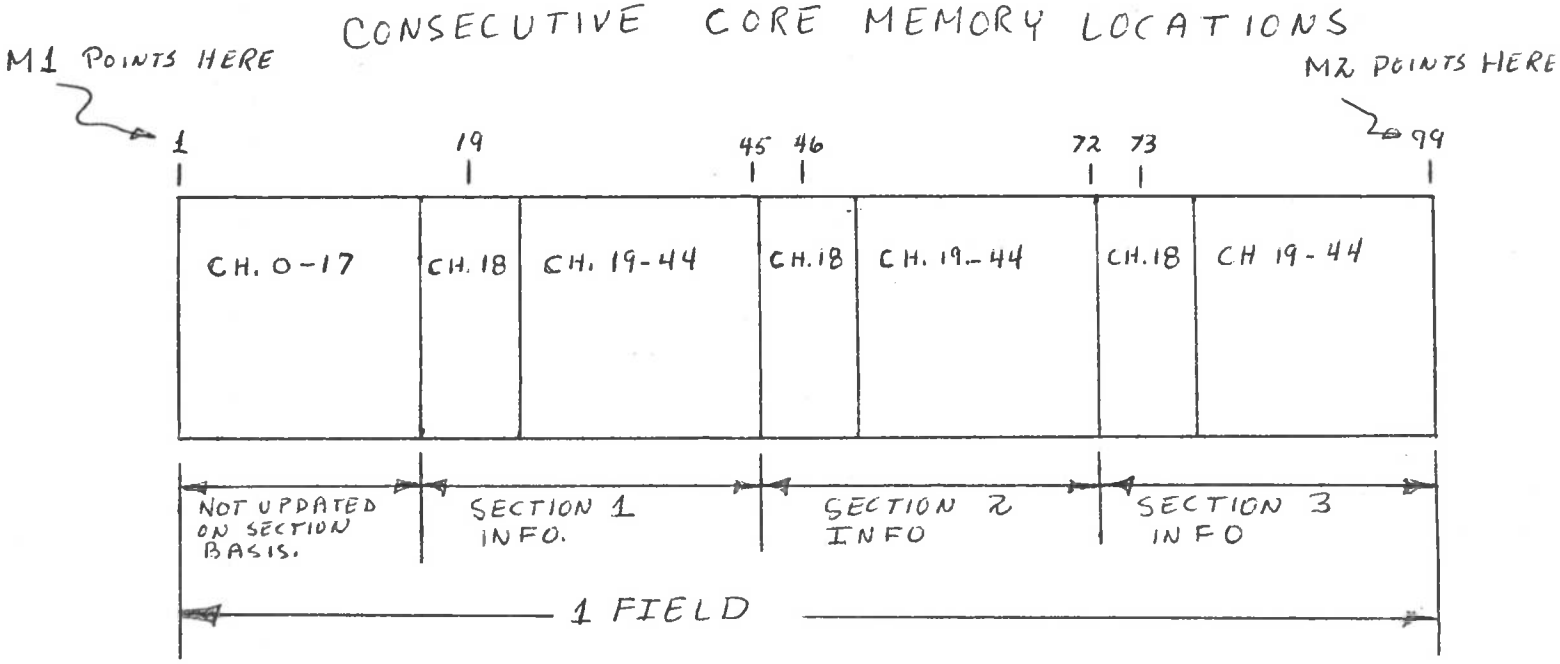

DIGITAL OUTPUT DATA FROM H-316
BUFFER 1
BUFFER 2
D-A CONVERTER IF REQUIRED
CH.0
CH.0 LOAD
CH.1
CHANNEL ADDRESS COUNTER
COUNT
RESET
PRESET
CH. 1 LOAD
OUTPUTS TO CAESAR
LAST CH. DONE
CH. 45
CH. 45 LOAD
UPDATE BUFFER 2
VERTICAL RESET
OR
SECTION CHANGE

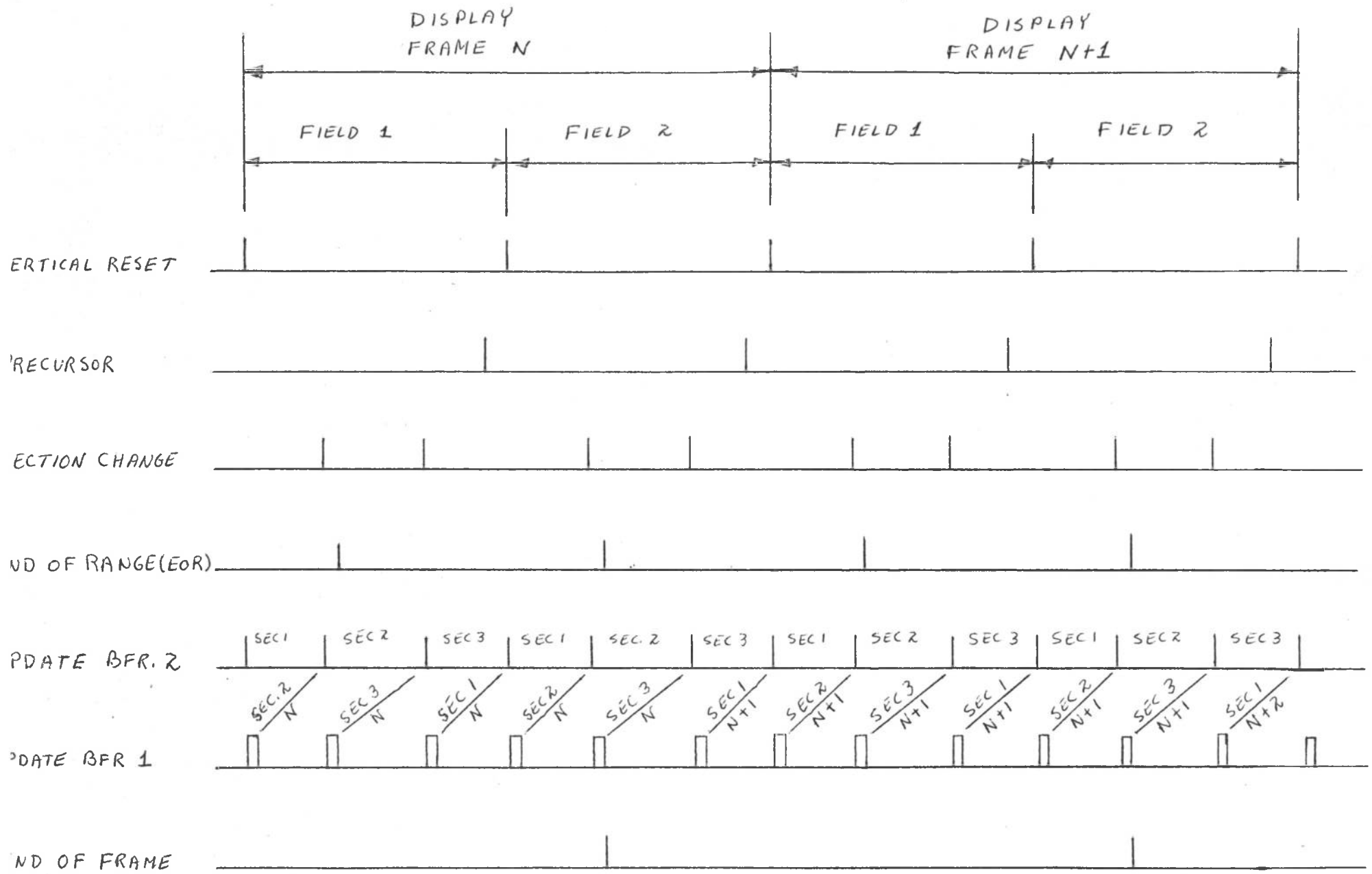
FIGURE 1

DATA STORAGE



INFORMATION IN CORE LOCATIONS 19, 46, 73 IS TRANSFERED TO THE SECTION LENGTH COUNTER. THE NUMBER TRANSFERED, IS THE NUMBER OF HORIZONTAL RESET PULSES USED FOR A GIVEN SECTION

FIGURE 2



TIMING

FIGURE 3

field 1 information may be equal to section 1, field 2 information, etc., for a specific frame without losing any information.

To set the operation into action, the software loads the reserved locations for DMC channel 3 with M1 and M2. Data for this frame is loaded into core memory locations 1-99 as shown in figure 2.

The H-316 now waits for the occurance of a vertical reset precursor pulse to allow initial synchronization. This signal is derived from the vertical reset pulse and occurs approximately 200 us prior to the vertical reset. After this happens the program issues a command enabling the automatic DMC action for channel 3. Immediately the hardware resets the channel address counter and requests a DMC update. Data is transferred sequentially from M1 through location 45 until the last channel (44) of the channel address counter is reached. The time for this transfer is approximately 150 us. Section 1 information is now loaded into buffer 1.

From now on, the vertical reset pulse and section length counter control the DMC action. Refer to figures 2 and 3 for the next chain of events.

Vertical reset occurs which updates buffer 2 with section 1 information, presets the channel address counter to channel 18 (the first channel to be updated on a section basis) and initiates another DMC request. This DMC request causes core locations 46-72 to be transferred, loading section 2 information into output buffer 1, channels 18-44. Time for the data transfer is approximately 100 us.

The next thing to happen is an overflow of the section length counter indicating the end of section one. This pulse updates buffer 2 with section two information, presets the channel address counter to 18 and

initiates a DMC request. Core locations 73-99 are transferred, loading section 3 information into buffer 1, channels 18-44.

Since we have reached core location M2, EOR occurs. EOR inhibits the preset line to the channel address counter and resets the channel address counter to channel zero. It also toggles an end of frame flip-flop. Two fields or two EOR signals comprise one frame.

The section length counter overflows again indicating the end of section 2 and buffer 2 is loaded with section 3 information. A DMC request is initiated and we start all over again loading buffer 1, channel 0-44 from core locations 1-45.

When vertical reset occurs we have completed the cycle.

If it is desired to animate the display, the information presented to the output interface must be changed. It is up to the computer program existing in core with the data to recognize the status of the end of frame flip-flop. When end of frame occurs, this implies all necessary information needed to finish the current frame has been transferred to buffer 1.

The computer program may now do one of two things.

Modify certain locations, between M1 and M2 with information which was calculated during the previous display, or change M1 and M2 to "point" to new core locations which contain information for the next frame, prior to the next section change pulse after end of frame happened.

All updates of buffer 2 occur while the display is blanked, eliminating transients in the display.

Seven sections maximum appear to be a desirable compromise with the present size of our core memory (8192 words).

7 MAR 74

CAESAR - MAJOR PROGRAMS PLANNED
GENERAL DESCRIPTION

1. ANIMATE

PROVIDES THE ABILITY TO ANIMATE BETWEEN 8 KEY FRAMES (7 INTERVALS). ANY OF THE 8 KEY FRAMES ARE AVAILABLE FOR INSTANT VIEWING AND/OR MODIFICATION

2. PLAYBACK

PROVIDES THE ABILITY TO PLAY BACK IN REAL TIME (30 FRAMES/SEC) ANIMATION WHICH HAS BEEN PREVIOUSLY STORED ON MAGNETIC TAPE

3. DELETE

PROVIDES THE ABILITY TO DELETE FRAMES FROM MAGNETIC TAPE

4. INSERT

PROVIDES THE ABILITY TO INSERT A "SEQUENCE" ALREADY EXISTING ON MAGNETIC TAPE AFTER A FRAME ON MAG. TAPE. PRIMARILY USED TO CREATE MANY CYCLES OF A SINGLE CYCL (NEW FRAMES ARE CREATED ON TAPE)

CAESAR - MAJOR PROGRAMS 7 MAR 74

GENERAL DESCRIPTION

5. COPY

PROVIDES THE ABILITY TO MOVE A FRAME OR FRAMES FROM POSITION A TO POSITION B ON tape AND REPLACING THE FRAMES THAT EXISTED IN POSITION B. IN GENERAL, NO ADDITIONAL FRAMES ARE CREATED ON TAPE.

6. SEQUENTIAL INSERT

PROVIDES THE ABILITY TO TAKE A SEQUENCE THAT WAS ANIMATED ON "ONES" AND DOUBLE FRAME OR TRIPLE frame that SEQUENCE. This IS USED PRIMARILY for SLOWING DOWN OF SEQUENCE WITHOUT "RE ANIMATING".

7. LIP SYNC

PROVIDES THE ABILITY TO SELECT LIPS, MOUTHS, EYES, ETC. AND STORE THEM AT THE DESIRED FRAME LOCATIONS UTILIZING THE DIRECTOR AND NOT THE TELETYPE

7 MAR 74

CAESAR

ANIMATE PROGRAM

THIS PROGRAM HAS BEEN EXTENSIVELY MODIFIED.

THE OPERATOR NOW HAS THE ABILITY TO HAVE INSTANT ACCESS OF UP TO 8 KEY FRAMES.

THESE KEY FRAMES MAY ENCOMPASE ANY FRAME INTERVALS DESIRED.

THESE KEY FRAMES MAY BE THOUGHT OF AS BEING LOCATED IN A SCRATCH PAD OF 8 SHEETS. THE OPERATOR MAY VIEW only 1 of the frames or sheets AT ANY GIVEN TIME, however he MAY FLIP BETWEEN ANY TWO OR MORE OF THE SHEETS AS DESIRED OR HE HAS The ABILITY TO FLIP AUTOMATICALLY THROUGH THE ENTIRE SCRATCHPAD at a PSEUDO SLOW MOTION RATE.

WHENEVER The OPERATOR WISHES TO MODIFY A KEY FRAME, HE STOPS HIS DISPLAY ON THAT FRAME AND SELECTS THE APPROPRIATE SECTIONS, FUNCTION SWITCHES AND ACTIVATES THE CONTROLS BY PRESSING THE ANIMATE PUSH BUTTON.

WHEN THE ANIMATOR IS SATISFIED WITH HIS SCRATCHPAD SEQUENCE,

CAESAR

ANIMATE PROGRAM

HE PRESSES THE "SAVE" PUSHBUTTO AND THE COMPUTER DRAWS THE IN BETWEEN FRAMES.

THE 8 FRAME SCRATCH PAD MAY BE FILLED IN SEVERAL WAYS. INITIALLY FROM A cold START, THE COMPUTER WILL ASK FOR THE NO. OF SECTIONS TO BE ENTERED AND THE COMPUTER WILL THEN "SECTION" THE ARTWORK AND DISPLAY IT AS FRAME 1 OF THE NEW SCENE OUT OF THE SCRATCH PAD AREA, SHEET 1. THE ANIMATOR WILL NOW "Build" THIS 1ST FRAME. WHEN THIS FRAME IS Built, THE ANIMATOR MAY "COPY" THIS FRAME ONTO ANOTHER FRAME NO. THAT WILL EFFECTIVELY be SHEET 2 OF THE SCRATCHPAD, by pressing THE "COPY" PUSHBUTTON AND ENTERING A FRAME NUMBER. WE NOW HAVE TWO FRAMES IN THE SCRATCHPAD. The ANIMATOR MAY VIEW THE FRAMES IN THE SCRATCHPAD BY SEVERAL techniques. HE MAY SELECT A SCRATCHPA FRAME TO BE VIEWED BY SIMPLY PRESSING THE APPROPRIATE NUMERIC

CAESAR

ANIMATE PROGRAM

Keyboard NUMERAL 1-8. IF HE presses "2" he will view the 2nd Key frame. IF "5" is pressed HE will see the 5th Key frame IN the scratch pad IF ONE EXISTS, ETC.

IN all CASES, The frame COUNTER will show the ACTUAL FRAME NUMBER

THE ANIMATOR MAY Also press THE FORWARD (→) OR BACKWARD (←) ARROW push buttons Which will MOVE THE APPROPRIATE DIRECTION IN The SCRATCHPAD ONE FRAME PER Pus

IF THE ANIMATOR WISHES TO "flip" through All OF The Key FRAMES HE MUST FIRST PRESS "PLAYBACK" which will display KEY FRAME NO. 1. Then, when the FORWARD ARROW IS PRESSED, EACH OF THE Key FRAMES will be displayed, IN ORDER, AT A Slow MOTION RATE.

AT ANY TIME THE ANIMATOR MAY "DELETE" A FRAME FROM THE SCRATCH PAD BY PRESSING "DELETE". THE FRAME THAT IS Deleted will be the ONE WHICH WAS being VIEWED AT THE TIME The Push button WAS Pressed. THIS

CAESAR

ANIMATE PROGRAM.

DELETE FUNCTION DOES NOT AFFECT MAG. TAPE STORAGE.

THE ANIMATOR MAY "COPY" The frame he IS VIEWING ON to ANY OTHER FRAME NO. DESIRED. IF The NEW FRAME NO. DOES NOT EXIST IN The SCRATCH PAD, IT will be INSERTED IN the proper place.

IF ANIMATION EXISTS ON MAGNETIC TAPE, The ANIMATOR MAY "RECALL" a frame or frames from MAGNETIC tape TO be PUT into the SCRATCH PAD.

The LAST MANIPULATIVE FUNCTION That CAN be performed IS THAT OF "TRANSFER PARAMETERS". The ANIMATOR MAY TRANSFER A CERTAIN SECTIONS parameters from the frame being viewed to ANY other frame IN the SCRATCHPAD. FOR EXAMPLE, IF IT IS DESIRED TO MAKE The 6th Key frame, SECTIONS 1, 3 & HORIZONTAL POSITIONS be identical with the 4th Key frame, the ANIMATOR VIEWS the 4th Key frame, presses "TRANSFER PARAMETERS", selects SECTIONS 1, 3 & 5 and sets ONE OF THE FUNCTION SWITCHES ON HOR. Position. Then enters

CAESAR ANIMATE PROGRAM.

The frame NO. corresponding TO The 6th Key frame INTO the Keyboard. ONLY THOSE PARAMeters selected by the section push buttons AND FUNCTION switches will be transfered.

— FAIRING AND SPECIAL Rotation —

The type OF FAIRING between ANY TWO ADJACENT KEY FRAMES will be ASSUMED LINEAR Unless the ANIMATOR VIEWS The first frame OF AN INTERVAL AND PRESSES ONE OF THE FAIRING Push buttons. THE ANIMATOR MUST be looking AT The first frame OF The interval to be faired.

A different type OF FAIRING MAY be selected between EACH OF The KEY FRAMES.

SPECIAL rotation allows a GROUP OF CONSECUTIVE SECTIONS TO BE Rotated MORE THAN 1 REVOLUTION OR IN A DIRECT OPPOSITE The MINIMUM ANGLE. The ANIMATOR MUST AGAIN be VIEWING The first frame OF The interval to contain the SPECIAL rotation.

October 29,1974

Sahib:

The enclosed poopsheets will give you something to gnaw on as far as Scanimate goes. If you look at the confusing block diagram, it also applies to Caesar, except where the 'artist manual control" goes in , plug in a computer controller with a memory and a helluva bank of software.

CAESAR --Computer Animated Episodes using Single Axis Rotation--like Scanimate, is a descendent of ANIMAC, the original animating computer designed by Lee Harrison, et. al. ANIMAC was an extremely resourceful, versatile, and impressive device. It could handle three-dimensional work as easily as two. However, it was a pain in the neck to control. This led directly to the development of Scanimate and to Caesar.

Scanimate is now a dependable production machine. Given a Kodalith to play with --or the input from a video camera, VTR, film chain, or just a bright blank area, it can and will produce shockingly beautiful patterns and movements. It can posterize a picture input or plasticize it. It is a real-time system, with a digital timer for sequencing up to five events on a single setup. You see what you are doing as you do it. You also tape it in real time. (2" videotape has proved to be our most convenient media, as it allows in-house editing as soon as the scenes are taped. Both Caesar and Scanimate are capable of being used in a film mode, but to put it plainly, it generally ain't worth it. The advantages of film are its high resolution/good image quality, since we are shooting directly off the face of our 945-line CRT, which otherwise would be converted to standard 525-line video pictures. The disadvantages are the slow speed of filming, ~~using three exposures per frame~~, and the inability to use more than one pass without either double-exposing or going to matte process work in the lab. Depending on the quality of your VTR's you can lay down several passes, printing one new object over the work already taped. Four passes is a practical limit, on one occasion we have succeeded with eight --but it was touchy.

(Besides, a good lab like Image Transform in Hollywood can convert your 2" quad into a pretty good-looking film at a fairly reasonable cost. . .)

CAESAR is a machine designed to take the drudgery out of animation. And it works. It and SCANIMATE are unique among the many designs of animating computers in that it is basically an analog device, rather than a digital one. In practical terms this means that two days' computer time will suffice for the average 30-second TV spot -- including editing. This does not mean that if you come in on Monday, you'll walk out Tuesday evening with the finished product under your arm. Instead, there will be about a week's lead time involved. You'll need a storyboard, character designs, and a small but irreducible number of drawings that will be converted by our friendly neighborhood stone carver into Kodaliths. You will need a soundtrack, and if lip sync scenes are involved, a 16mm magnetic dub from your ¼" original track, as well as a day or three to get it read and converted to barsheets. In other words, most of the preliminaries for successful conventional film animation still hold. i.e. setting objectives and planning approaches. It is possible to "wing it" a little, but be prepared to run overtime, while you make up the missing pieces that turned out to be necessary. The embarrassing part of this whole operation is that it usually takes an experienced artist longer to make a finished comp storyboard than it does to animate it . . .

What do we maan by 'Kodaliths"?

Well, sir, Caesar has to 'see' the artwork before 'he' can move it about. (Why the parenthetical 'he'? Because Caesar is only a machine. A tool. As thoroughly nonhuman as a crowbar. I call him 'he' in the same sense that that a frontiersman called his rifle "she" and bestowed a name upon it, or that a seaman uses when he calls his ship a she. . . fondness for a reliable tool, and perhaps a touch of superstition, which I would deny in public.)
A Kodalith, as we use them, is a positive transparency with an opaque surround. The drawing in the middle passes light. Black lines on the drawing are represented on the Kodalith by lines screened to pass only 10% of the light behind them. Caesar --and Scanimate-- can identify five "grey levels". The first grey level is "background" and can be forgotten. It can be a solid color generated by the machine, or a video background piped into it. No matter. The second grey level is usually encoded as black for outlines (read: painted as black). and is represented by the engraver's 10% screen. The third grey level is represented by a conventional BenDay screen --Letraset's # 237 has proved reliable-- and is usually encoded for a dark color. The fourth --Letrasets #173-- is usually encoded for a light color, and the clear areas on the Kodalith are usually encoded as white. What this means to the artist is that for his first pass, he

Kodalith directly to the artwork

has only black, white, and two colors to work with. If he can manage a second pass, using a toned overlay to fit his original Kodalith, he may add up to four colors more. A third would give the artist four more colors, and a very bad name among our engineers. It is best to design your characters with two colors only to require only one pass. The image quality is a little better, and you save an additional twenty minutes time in taping the second pass. And another twenty minutes in taping the third... This can be very important to you. If you have allowed two days in which to shoot your thirty-second spot, and the spot contains eight scenes (chronic optomists may include more) then your taping time alone will amount to about two hours and forty minutes. Two passes per scene will use five hours and twenty minutes, and so forth. It is quite possible to plan animation that cannot be completed within the sixteen working hours allotted. If you are working on a job that we have bid a fixed price on, that will not bother you . . . unless your air date happens to fall at the end of those sixteen hours.

The Kodaliths look unusual in another way. The character has been dissected into sections. Every part of the character that will animate independently of the others is now separated by a narrow vertical gap. These separate sections also overlap each other, reading from from left to right. We can use up to eight secions in any one pass. Because of the difficulties is registering additional sections to animation already completed, it is not recommended that you design a figure with more than eight sections. (Note to animators: yes, this is exactly like having eight cel levels. But don't use the term 'levels'. During development our engineers borrowed the word to refer to the grey scales used, and it confuses them no end if we apply it to their "overlap".)

when we animate

Suppose we are sitting down to animate a character: what happens? First, we 'section' the figure into those eight sections (cel levels) that I just mentioned. Then we set the rotation points --each section has an axis that it will rotate around. Then the oscillators or "section benders". We have three. The "horizontal oscillator" bends a section along its long axis, the vertical oscillator, the short way...or it may be set so they both work on the long axis. We have a choice of four waveforms: sine wave (wavy), triangular wave (sawtooth), ramp wave (like a sawtooth, but with the righthand side vertical instead of slanted. Virtually useless, but our engineers included it because it was easy to generate, and what the heck, it might be good for something...) and finally, the square wave (which isn't. It has a profile like a gear tooth, but it's very, very useful.) If you set both oscillators the long way, you can apply

both of them to a single section, as, for instance, a triangle wave to make an elbow in an arm, and a square wave to make a wrist. Or two sine waves. or whatever. The last oscillator is the "depth" oscillator. It makes your section taper toward a vanishing point, and, like the other oscillators, may be animated independently during the scene. Your artwork is still basically flat, like a paper cutout, but now you can pick it up and move it as if it were a three-dimensional paper cutout. Convincingly.

At this point, some animator will ask: "Hey, what about a solid object like a head? Or mouths for lip sync? If it's flat art, how can I turn it around or ~~peel~~ twist the mouth ~~off~~ to get the shapes I need to make it talk?"

Good question, and our engineers came up with a beautiful answer. You remember our Kodalith, of course. If you did it most efficiently, it's in a three-by-four format, just like your faithful Oxberry Standard Field Guide. You'll notice that the head you'd like to turn is sitting alone in solitary grandeur surrounded top and bottom with a lot of empty space. One thing led to another, and our engineers came up with a feature they call "section blanking".. Basically, this means you can build a stack of heads --or mouths-- or whatever, animated in the good old conventional manner, and hide the ones you aren't using until you need them, then pull a one-frame substitution, every bit as undetectable as the one you set up on your Oxberry, Acme, or Whatever. Then, possibly just to show off, those same engineers designed a program that lets you take just one of those heads or whatevers, animate it through whatever gymnastics you require, and then, using the old keyboard, tell CAESAR which frames you would like to substitute which heads upon. And CAESAR will not only do the substituting, he will keep your animation intact throughout.

Our engineers weren't content just to add whipped cream, they wanted a cherry on top: a second camera looking at a second ~~subsystem~~ Kodalith provides another art input. Do you have more heads than you can put on one section? Or more sections full of heads than ~~your~~ you can afford? Put some of them on the other camera in a matching setup, and substitute them at will.

If you, Mister Animator, thinks this gives you a world of freedom in animating characters, you are oh so very, very right.

Let's say you have all these pieces on Kodaliths, and there they are, staring at you from an ostensibly ordinary color TV screen. How do you actually animate them?

Well, first, you have some knobs (potentiometers) (knobs to us animators) each set to a function switch. Set one switch to "horizontal position" and another to "vertical position" and a third to "rotation" and you can move one --or two, or three, or eight-- sections anywhere on the screen you want them, just like building a paper cutout. When the figure is complete ("okay, that's frame one!") then you hit the"copy" button and Caesar asks you ~~[illegible]~~ (via a little black and white CRT) which frame you'd like all this copied on. You're working in video rates, now, not movie soundspeed, so you know that you're using thirty frames to the second instead of twenty-four. Let's say it's a run cycle --fast, realistic run-- with one foot hitting the ground every third of a second. You copy it to frame 10, and frame 20. This will close the cycle. You then look at frame 10, and move all the pieces until they make the right pose, just as if you were moving paper cutouts --except that you can bend these cutouts. Squash and stretch is supplied by setting your knobs to "horizontal size" and "vertical size". When you're more or less satisfied, punch the ~~[illegible]~~ "store" button, and CAESAR ~~[illegible]~~ will fill in your inbetweens. With accellerations/decelerations/or combinations thereof, if you ask him. And return the results for playback in less than twenty seconds...for complicated actions. Let's say the results have a few flaws... if you were doing it on cels, you'd grit your teeth and let them go, since it would cost too much to make them look good, but since it's CAESAR, you go back. You call back the frames you want to monkey with (up to nine at one shot) and change them to suit: new positions, new accellerations, whatever. Looks okay at last? It's a good cycle? All right, you tell CAESAR you'd like him to repeat that action ten or twenty times (pick a number, any number) and CAESAR, dutiful slave that he is, copies it off and returns ready for duty inside those same twenty-or-so-seconds, while you drum your fingers in your best Peter-Ustinov-playing-an-impatient-Nero imitation.

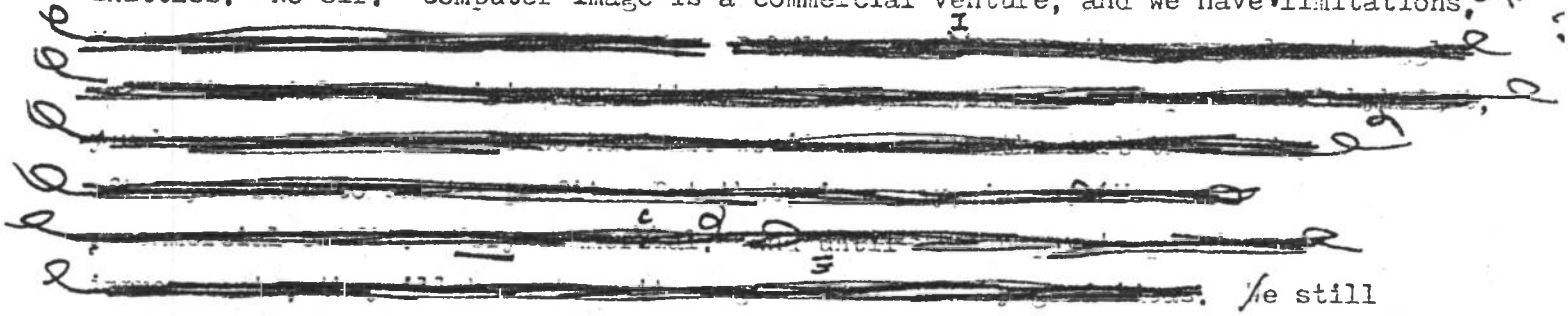
Now you have your run cycle. Would you like to move it across your landscape? You still have three controls you haven't even touched: character vertical and character horizontal will let you move your characters where you will within the setting. If their feet slip over the ground ~~[illegible]~~ surface, well, call the frames back and try it again. Even ten tries --and you'll do it in less than four-- are still ~~[illegible]~~ faster than trying to figure it out the hard way... that is, the way you've always had to do it.

And then there is your depth control. Yes, depth. You'd like to animate a character coming towards you in a 3/4 front view? Or head-on? Nothing easier, friend. Just build your cycle, set the end positions of the whole move by trial-and-error, and you've got it. Don't like it? Try again.

Now let's say the animating is over and you're about ready to tape the scene. You'd best check your colors --they're under computer control, too. Did you want to change them during the scene? Well, sure, animate that in, too. You can certainly do it in one 'animate'. Fades and dissolves, and most editing effects are still manual --for now-- but you can put them in as you tape the scene, or later, when you edit it. All set? One last check to make sure your intensities look good, overlap is tweaked to perfection, and then ring up the tape room and let her rip.

...Of course, our engineers have allowed us to start a tape machine, a scanimate, and CAESAR with the same pulse, with ~~whatever~~ whatever delay you'd like, so, after very little jiggering and fitting on your part, the soundtrack goes on tape in perfect sync with your animation, and you modestly accept the plaudits of the multitude. Was it only a music track? Well, you didn't send that out for a 16mm mag transfer, not if you can drum your fingers to a beat. The TAPTIMER program let you tap a key to the beat of the music (or action) and read off the frame numbers on which you struck that key...and if you're too lazy to enter it on your barsheet, CAESAR will print you a copy on his teletype... with the differences subtracted out so you can detect patterns when they occur.

It wouldn't be honest for me to say that animating on CAESAR is all beer and skittles. No sir. Computer Image is a commercial venture, and we have budget limitations.



We still can't have a figure touch a moving background and register with it without slipping one way or the other. We know how to do it; we just don't have the budget for it yet... but when we do, we'll be able to do layered backgrounds like Disney's multiplane crane camera.

Did you want to use CAESAR in real time? We have real-time inputs, and with a little preplanning can make him do anything short of making the morning coffee (the local coffee service is a more cost-effective operation)
For that matter, if you have a more-or-less specific simulation task, we'll haul off and build some peripheral hardware that will let you do your simulating in real time, with more realistic art than you can get elsewhere. And possibly cheaper.
Eventually, CAESAR will read his own soundtracks for you, and do his own editing. He'll keep a library of characters ready to animate, and another library of movements analagous to your familiar sound effects library...much handier than trying to save your old drawings and cels. How many times have you drawn that particular walk cycle, anyway?

I really have been a little too cavalier with the other people involved in computer animation...I should not belittle either genius or honest hard work --and figuring out how a machine should think is the hardest sort of skull sweat going. In a way, ~~and~~ we were lucky. We picked an approach to animation that worked fast and well, and didn't require the tedium of programming --telling the computer what the object looks like-- in digital coordinates for every confounded corner, edge, ~~and~~ angle, and surface shown and hidden. This, frankly is a pain. It took Charles ~~and~~ Csuri a full eighty hours to produce a ~~simple~~ "wire-cage" model of a P40 Thunderbolt...before he could begin to animate.
I ~~and~~ am not belittling that accomplishment. That construct can be animated to simulate three-dimensional art with a facility that defeats pencil-and-paper animators, no matter how expert. Its drawback is strictly commercial: it ~~can't~~ does not produce a sufficiently goodlooking picture fast enough to be marketable. Detailed, full-color 'three-dimensional' pictures such as those produced by ~~David~~ Donald P. Greenberg's architectural simulations at Cornell require a full two seconds to compute and paint onto the screen, once the programming has been accomplished. That is still 59 pictures short of the number we need for that two-second period. And there doesn't seem to be a strategy available to reduce the time involved without building 59 times more computer than you started with --and that way lies bankruptcy.
We simply had the good luck to have the engineers who picked the one route that works rapidly, easily, and well. And we should show a little humility.

of Ohio State University

It ~~and~~ produced broadcast-quality full-color picture.

Especially since eventually, we'll be using a great many of those same techniques ourselves in conjuction with our existing system. CAESAR with bells and chimes, so to speak.

I suppose that Computer Image is, in a way, a little like the flea on an elephant. For him, that elephant was the entire world, and one day, he realized he had the whole world by the scruff of the neck... but the world didn't know it yet.

So, to wake the world up, part of Computer Image has gone west to Los Angeles to become 'Image West' and take on the Tinseltown market area, while CAESAR, being a one-of-a-kind prototype, stays with his engineers in Denver for further development, doing animation for Image West from a distance.

That's the 'how-to' at the moment. The straight gen.
But there's a little more to it than that. Animation has been losing ground in recent years as the cost of handwork and drudgery goes steadily up. Studios have gone to Xerox "inking" or other photomechanical processes. Disney has gone to live-action films for its bread-and-butter. Hanna-Barbera has gone to limited animation until it seems they've cornered the field, and the Japanese studios are looking forward unhappily to the day their animator's wages go up. TV animation has succumbed to time and cost pressures to the point where the animators who work for TV call their shops "sausage factories", ... because every episode of every show looks like every other.

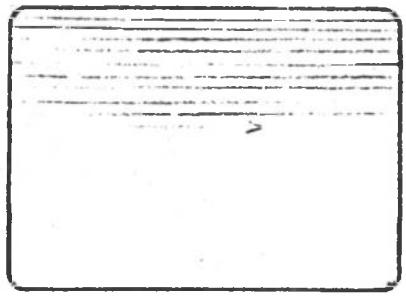
CAESAR could be turned into a 'sausage machine'-- may I never live to see the day. You see, the people that buy this sort of animation have forgotten that the thing that gives animation its value is that it is entertainment. It is fun. It is "theater". Watch your kids when you take them to Snow White and then watch them on Saturday morning... as they ignore the shows and only turn to watch the commercials. The commercials-- bad as they often are-- are generally better "theater" than the supposed entertainment.

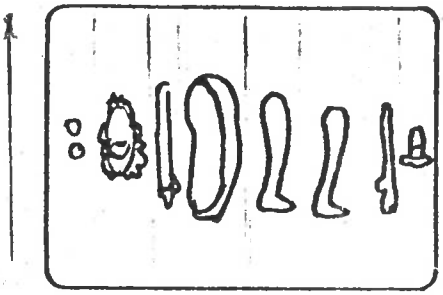
CAESAR, however, is fast. By a factor of at least 30. And he is markedly less expensive (we still show a profit). He allows the client to sit in as director (now there's an innovation) And by reason of these virtues, he will let you put the fun back in... the originality, the creativity, the surprises, the pretty, graceful, formerly-expensive movements.... and let you make something that will amuse, charm, please, or enchant the people you set out to reach when you started this thing.

CAESAR

COMPUTER
ANIMATED
EPISODES THROUGH
CHAOS
AXIS
RATION

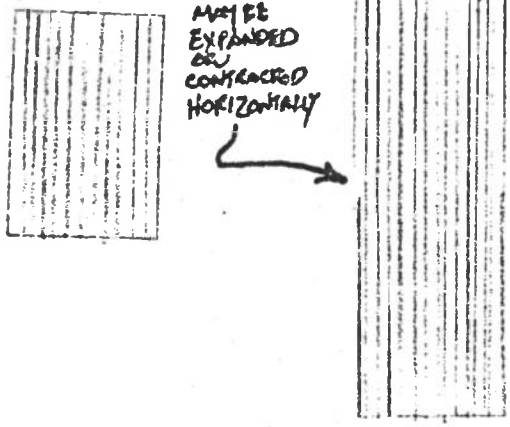
...A HELLUVA LONGER WAY
AROUND FOR ONE LOUSY
ACRONYM...

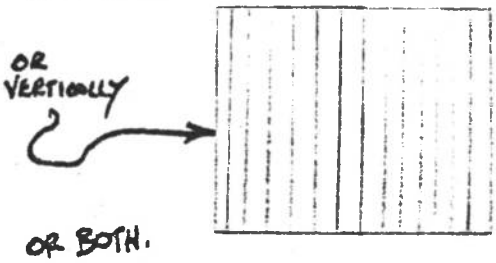




ARTWORK IS SET UP IN UP TO 8 SEGMENTS ("BONES")
OF VARIOUS WIDTHS.
THEIR SEQUENCE DETERMINES THEIR 'DEPTH'
-- WHICH 'CEL LEVEL' THE ART WILL BE ON.
COLOR IS PROVIDED BY GRAY SHADINGS --
FIVE MAXIMUM, INCLUDING BLACK & WHITE,
AND BACKGROUND!

THE RESULTING SEGMENT(S) OR SECTIONS





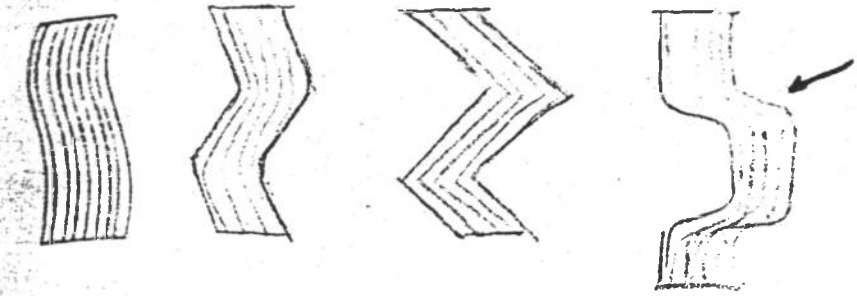
OR BOTH.

THE AGGREGATION OF
SCAN LINES IS CALLED
A RASTER.

~~THIS~~ HAS AN OSCILLATOR THAT CAN BE APPLIED TO IT
~~IT~~ WILL DELIVER ONE OF FOUR WAVE FORMS

SINE TRIANGULAR RAMP OR SQUARE (WHICH ISN'T)

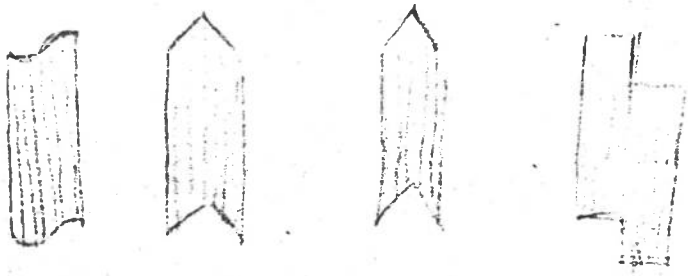
USING THE VERTICAL OSCILLATOR, WE GET THESE FORMS:
(VERTICAL PHASE-LOCKED OSCILLATOR)



NOTE THE 'GEAR TOOTH' PROFILE.

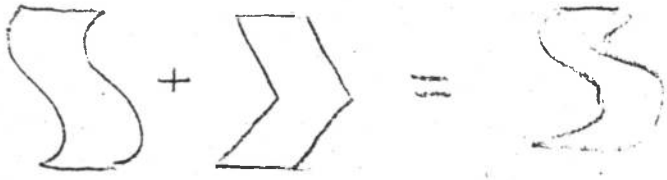
35 microseconds per sweep

USING THE HORIZONTAL OSCILLATOR, WE GET THESE:



1 ~~6~~ milliseconds per raster.

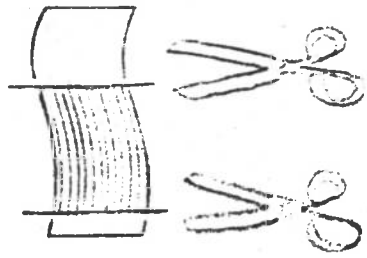
TWO WAVEFORMS MAY BE ADDED TO GET A COMPOSITE:



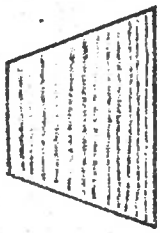
AND THE LENGTH OF THE WAVEFORM MAY BE CHANGED. (FREQUENCY)
AS WELL AS ITS SIZE (AMPLITUDE).

IN ADDITION 'SIGNAL BLANKING' MAY BE USED TO HIDE OR 'ERASE' EITHER OR BOTH ENDS OF THE RASTER.

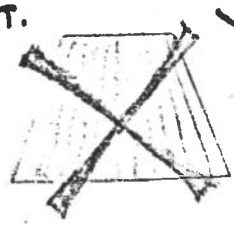
YOU MAY DISPLAY ONLY THE PART YOU WANT.



BY APPLYING AN OSCILLATOR'S SIGNAL TO THE 'HORIZONTAL SIZE' WE PRODUCE AN ARTIFICIAL PERSPECTIVE.

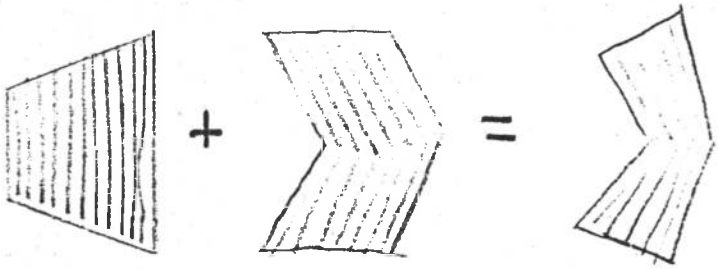


IT DOESN'T WORK VERTICALLY: CAESAR IS NOT YET SMART ENOUGH TO MAKE THE SCAN LINES DIVERGE— LET ALONE TO HOLD THEIR INTENSITY CONSTANT.



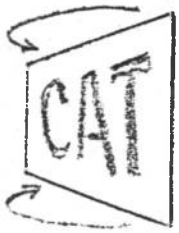
BELAY THAT! THEY TAUGHT HIM A NEW TRICK.

ADDING THIS— THE HORIZONTAL SIZE (DEPTH) OSCILLATOR TO THE VERTICAL OSCILLATOR'S WAVEFORMS GIVES US A SOMEWHAT DISTORTED PERSPECTIVE:



IT DOES TEND TO 'PINCH' AT THE WAIST.

YOU CAN USE THE DEPTH OSCILLATOR TO 'SPIN' A RASTER

FROM THIS 

TO THIS

OR THIS

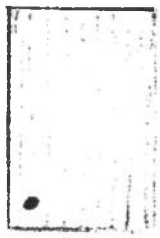
.... YOUR CHOICE.

CAESAR DOES NOT RECORD THE VIDEO SIGNAL -- THE ARTWORK -- HIMSELF. HE ONLY 'SEES' AND REMEMBERS THE RASTERS, THEIR POSITION, AND THEIR WAVEFORMS. THE ARTWORK IS RECORDED ONTO VIDEOTAPE ON THE FINAL PLAYBACK.

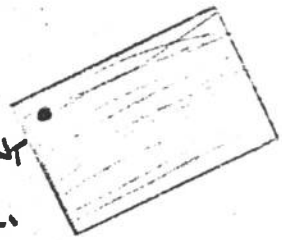
A SEPARATE MONITOR SHOWS YOU THE WAVEFORMS AND WHAT'S HAPPENING TO THEM.

... INCLUDING, IF YOU WANT IT, ROTATION POINTS FOR EACH RASTER.

THE POINT STARTS IN THE MIDDLE, BUT, YOU CAN MOVE IT ANYWHERE AND LOCK IT IN PLACE WITH THE RASTER .....

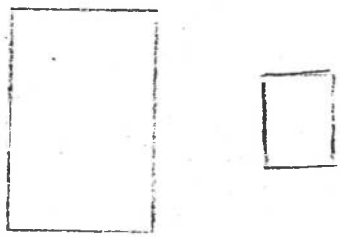


THEN ROTATE IT 360° PLUS...



THE ROTATION POINT NEED NOT STAY WITHIN THE RASTER.

AND THE DEPTH CONTROL WORKS ON BOTH THE HORIZONTAL AND VERTICAL SCAN TO REDUCE THE RASTER... TO A DOT, IF NECESSARY.



THE PROGRAM IS NOW WRITTEN SO YOU DON'T HAVE TO DO YOUR OWN ARITHMETIC. IF YOU WANT A MAXIMUM-POSSIBLE FAIRING, JUST PUNCH IN A LARGE NUMBER -- LIKE 9999 AND CAESAR WILL TAKE CARE OF IT. IT DOESN'T FRIGHTEN HIM ANYMORE

UP TO NINE NOW

FROM AN ANIMATOR'S POINT OF VIEW, THIS GIVES YOU ENORMOUS FLEXIBILITY: EVERY ELEMENT CAN BE SQUASHED, STRETCHED, MOVED, BENT OR WHATEVER FREELY.

YOUR MOVEMENTS ARE TIMED AT 30 frames/second (AS AGAINST SOUNDSPEED'S 24).

YOU ALSO HAVE A CHOICE OF 'FAIRINGS' (SLOW-INS AND SLOW-OUTS) -ACCELLERATIONS TO SMOOTH THE START AND/OR STOP OF A MOVEMENT:

LINEAR: NO FAIRING. START AND STOP ABRUPTLY.
SLOW-IN: ACCELLERATE TO START
SLOW-OUT: DECELERATE TO END
} MAXIMUM LENGTH = LENGTH OF MOVE − 1

DOUBLE-ENDED: ACCELLERATES STARTING, DECELERATES STOPPING.

$$\text{MAXIMUM LENGTH OF FAIRING} = \frac{\text{LENGTH OF MOVE} - 1}{2} - 1$$

THE NEW -- I SUPPOSE I SHOULD SAY 'CURRENT'-PROGRAM GIVES YOU EIGHT 'KEY' FRAMES TO WORK WITH.

YOU SPECIFY THE NUMBER -- FRAME NUMBER -- OF EACH KEY FRAME (i.e. ITS TIMING) AND THE FAIRING (TYPE AND LENGTH) BETWEEN EACH.

THEN MOVE AND MODIFY YOUR ELEMENTS, ONE FRAME AT A TIME, 'FLIPPING' BACK AND FORTH BETWEEN THEM.

WHEN YOU HAVE THOSE FINISHED, TELL CAESAR "GO FETCH" AND HE'LL DO YOUR INBETWEENS FOR YOU, AND, IN ABOUT A MINUTE, PLAY THEM BACK FOR YOU.

IF YOU DON'T LIKE ANY PART, YOU CAN CHANGE IT. RENUMBER YOUR KEY POSITIONS (CHANGE TIMING), CHANGE FAIRINGS, EVEN GO BACK AND CHANGE ELEMENTS ONE FRAME AT A TIME, IF YOU LIKE.

CAESAR WILL ALSO LET YOU BUILD A CYCLE ACTION, THEN WILL DUTIFULLY COPY IT AS MANY TIMES AS YOU LIKE ON WHATEVER FRAMES YOU LIKE.

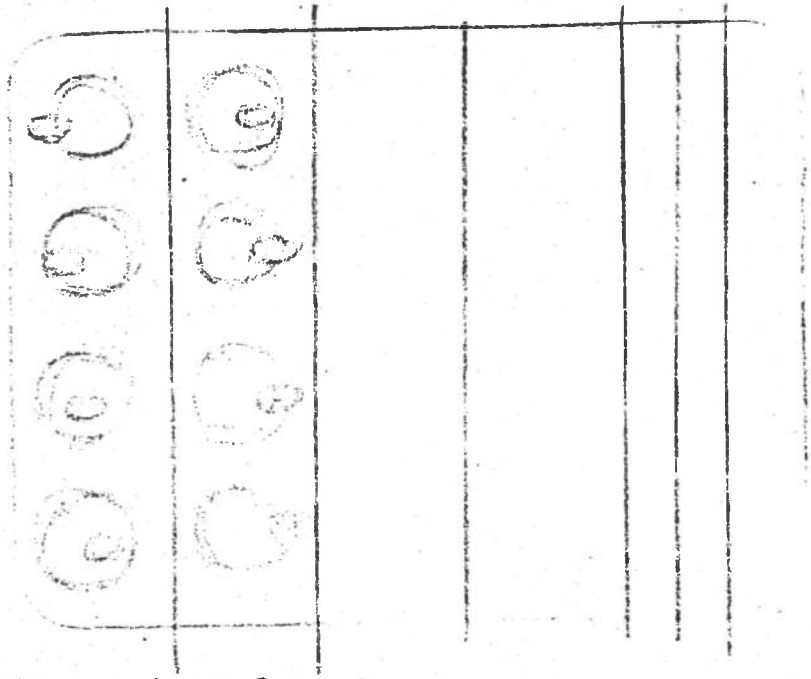
YOU CAN DO A WALK CYCLE IN PLACE — THEN RECORD IT FOR LENGTH — THEN POSITION THE ENDS OF THE WALK AND TELL CAESAR TO RE-ANIMATE FOR POSITION (INCLUDING DEPTH, IF YOU LIKE) AND YOUR FIGURE WILL WALK RIGHT ACROSS THE SCREEN.

"LONG" MOVES -- A THREE-DIMENSIONAL TURNING MOVEMENT --

...DON'T WORK PLAYED STRAIGHT. CAESAR DOESN'T SEE THE ART, ONLY THE RASTER.

THERE ARE TWO WAYS AROUND IT:

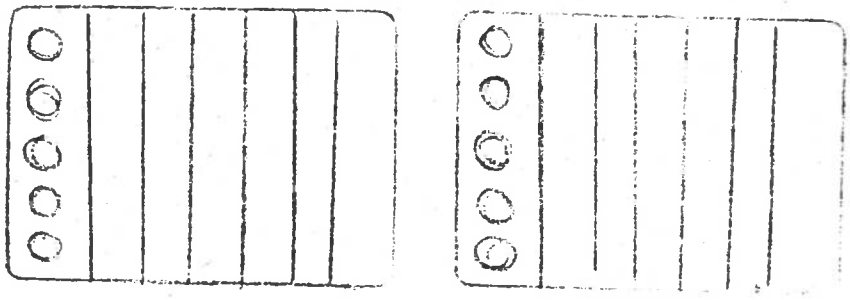
ONE: ACTUALLY ANIMATE THE MOVE, BY DRAWING IT FRAME-BY-FRAME. THEN MOUNT THE ARTWORK, SEVERAL PIECES PER RASTER

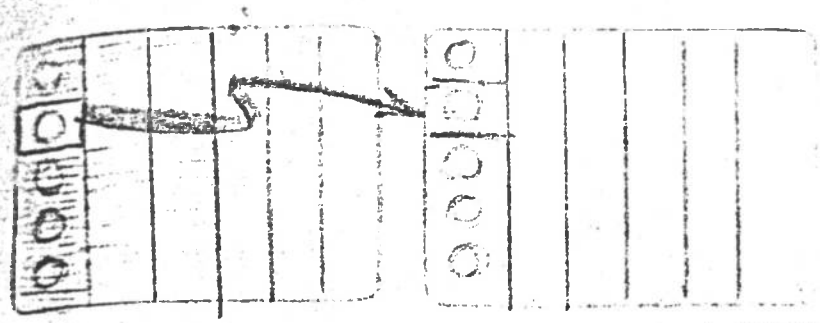


THEN USE ONLY THE PORTION OF ONE RASTER YOU NEED.

CAESAR HAS TWO CAMERAS TO LOOK AT ARTWORK.

YOU CAN SET UP ARTWORK LIKE THIS....





...AND CAESAR CAN SWAP ONE WHOLE RASTER SECTION IN ONE PICTURE FOR THE MATCHING SECTION ON THE OTHER. OBVIOUSLY, YOU CAN PUT A LOT OF PICTURES INTO HIM TO SWAP AND PLAY WITH.

THE OTHER WAY, OF COURSE, IS TO BREAK DOWN THE FACE INTO AS MANY SEPARATE ELEMENTS AS YOU NEED, AND BY SELECTIVELY ANIMATING AND DISTORTING EACH ELEMENT, MOVE THEM 'AROUND THE CORNER'. THIS, OF COURSE, IS A BUMMER: IT WASTES SECTIONS, AND IT'S A TIMEKILLER. IT ALSO IS SUITABLE ONLY FOR VERY STYLIZED CHARACTERS, AND THEN ONLY IN CLOSEUP. FOR NOW, YOU'RE BETTER OFF BACK AT THE OLD DRAWING BOARD FOR TURNS.

SWAPPING SECTIONS IS REALLY SOMETHING OF A WASTE. A "CEL-BY-CEL" MOVE, NO MATTER HOW WELL ANIMATED, TENDS TO FLICKER. BETTER TO SELECTIVELY DISTORT / SINGLE DRAWING AND LET CAESAR MOVE IT SMOOTHLY THROUGHOUT.... AND BESIDES, IT'S MUCH FASTER. YOU JUST BEND AND MOVE OVER TWO KEY FRAMES, AND YOU'RE DONE.

NOT TRUE ANYMORE. I'VE BEGUN IT.

NOW TO MODIFY THAT...

OUR 'SECTION BLANKING' PROGRAM HAS BECOME A GEM. INSTEAD OF HAVING TO MANUALLY EXCHANGE ONE OBJECT ON A SECTION FOR ANOTHER EVERY TIME YOU NEED IT, YOU CAN NOW STORE SOME 'REFERENCE FRAMES' ON ANOTHER SCENE, DO YOUR CHANGES ON THEM, DO YOUR ANIMATION WITH ONE SECTION (SAY, ONE MOUTH) AND DO ANYTHING YOU WANT. THEN YOU TELL CAESAR YOU WANT TO SUBSTITUTE THE MOUTH ON FRAME 2 IN THE REFERENCE SCENE FOR THE ORIGINAL, AND DO IT ON FRAMES 17, 21-24, 31, 37.... RK.

AND – YOU MAY USE "SPECIAL BLANKING" WHICH LETS YOU MAKE A STATIONARY 'WINDOW' AND MOVE THE SECTION BEHIND IT.

WHEN YOU'RE DOING LIP SYNC, YOU'LL USE SPECIAL BLANKING ON THE MOUTH SECTIONS. YOU'LL DRAW THE MOUTHS YOU NEED – HANNA-BARBERA'S SYSTEM IS HANDY --

"A" – MOST CONSONANTS

"B" – "EE" & INBETWEEN "A" & "C"

"C" – MOST OPEN MOUTHED VOWELS

"D" – 'M', 'B', 'P', AND, OFTEN, A STUPID SMILE

"E" – "AW" & INBETWEEN "F" & ANYTHING ELSE – TEETH OPTIONAL

"F" – "O" & "OO"

"?" – CHARACTER'S EXPRESSIONS WHICH DO NOT FIT THE REST OF THE SYSTEM.

YOU'LL READ YOUR TRACK AS PER USUAL -- AND WE'RE WORKING ON A WAY TO TAKE THAT OUT OF THE HORSE-AND-BUGGY ERA -- AND ASSIGN YOUR MOUTH POSITIONS BY GOOD JUDGMENT, ETC. ON YOUR BARSHEET – AS USUAL.

BUT – YOU WILL PUT ONE MOUTH ON THE FIGURE AND LEAVE IT ON AS YOU ANIMATE YOUR WAY THROUGH THE ACTION -- NO CHANGES.

YOU WILL BUILD A SIX-OR-MORE FRAME 'LIBRARY' OF MOUTHS IN ANOTHER SCENE (OR THE HEAD OR TAIL OF THE ONE YOU'RE WORKING IN)... THEN USE 'BLANKING CONTROL' TO TELL CAESAR WHICH FRAMES YOU'D LIKE THE "B" MOUTH ON, AND WHICH GET THE "C"... AND SO WEITER. CAESAR WILL KEEP THE ANIMATION INTACT, AND ADD THE MOUTHS TO THE FRAMES YOU SPECIFY.

USE THE 'CAESAR DELAY' PLAYBACK TO CHECK YOUR SYNC AND TO RECORD A SYNC TRACK WITH THE ORIGINAL FOR EDITING.

PREPARING ARTWORK

KODALITHS SHOULD BE 3x4 FORMAT
UP TO 12F SIZE ——— 10F PREFERRED!
(CAN FOCUS DOWN TO 2x2 SLIDE)
CENTERED ON 12F PEGGED CEL
UP TO 8 SECTIONS
USE AS MUCH AREA AS POSSIBLE - YOU ONLY HAVE 945 LINES WITH WHICH TO PAINT ALL 8 SECTIONS.

IDEALLY ALL YOUR KODALITHS SHOULD JUST FIT SNUGLY IN ONE FIELD SIZE. SO THAT YOU NEEDN'T MOVE THE CAMERAS SCANNING YOUR ARTWORK.

YOU SEE, YOU CAN NOW CHANGE KODALITHS, ANIMATE ANOTHER SCENE, AND STILL HAVE THE FIRST ONE INTACT, READY TO CLEAN UP AND TAPE.

IF, HOWEVER, YOU MOVE THE CAMERA OR MAKE ANY ELECTRONIC ADJUSTMENTS THAT'S IT--
YOU'LL NEVER GET IT BACK.

THE ART INPUT IS ANOTHER AREA WE'RE LOOKING AT. YOU SHOULD BE ABLE TO BUILD A CHARACTER ONCE, PUT THAT INFORMATION ON A TAPE, VIDEO AND ALL, AND PUT THE CASSETTE ON A SHELF UNTIL YOU NEED IT AGAIN.

AN 'IDEAL' CHARACTER FOR CAESAR ANIMATION IS A STUBBY LITTLE FELLA...

...TO READ READILY ON A TV SCREEN.

HIS OUTLINES AR BOLD. WIDTH MAY VARY

HE USES ONLY FOUR COLORS --INCLUDING BLACK AND WHITE, IF YOU'RE USING THEM. A SECOND PASS WILL ADD UP TO FOUR MORE ....AND WILL ADD TWENTY MINUTES TO YOUR TAPING TIME AND ONE GENERATION TO YOUR MASTER. IT'S A NUISANCE.

IF HIS CLOTHING IS PATTERNED THE PATTERN SHOULD BE LARGE --YOU'VE SEEN SHIMMERING CLOTHES ON TV PERFORMERS. YOU WILL BE CRITICIZED IF YOUR CHARACTERS SHIMMER. (JOHNNY CARSON CAN; YOU CAN'T. THERE AIN'T NO JUSTICE)

HE BREAKS DOWN INTO NO MORE THAN EIGHT PIECES FOR ANIMATION. THIS EXAMPLE WOULD REQUIRE 1 HEAD, 2 ARMS, 1 BODY, 2 LEGS MINIMUM. HIS MOUTH WOULD PROBABLY BE A SEPARATE SECTION, SO YOU HAVE ONE SECTION FREE FOR HAT OR EYES OR AN 'PROP' FOR HIM TO CARRY.... OR TO BE USED AS A SPECIAL 'STAGE FLAT'.

WHAT DO I MEAN? WELL, THERE ARE FIVE 'COLORS' IN CAESAR. THE BOTTOM ONE IS 'ZERO' OR 'BACKGROUND'. IF YOU TAKE A RECTANGLE AND TURN ITS INTENSITY TO ZERO, IT BECOMES INVISIBLE. THE BACKGROUND SHOWS THROUGH. IT ISN'T GONE. IT STILL OVERLAPS ALL THE SECTIONS THAT IT DID BEFORE BECOMING INVISIBLE.... AND ANY SECTIONS THAT PASS 'BEHIND' IT ALSO DISAPPEAR. NOW IF YOU LINE YOUR STAGE FLAT UP WITH THE EDGE OF A DOOR....

ART BREAKDOWN FOR HIM
MIGHT LOOK LIKE THIS

...AND HIS FAR ARM AS SECTION (8)
— AS IN SECTION (1)

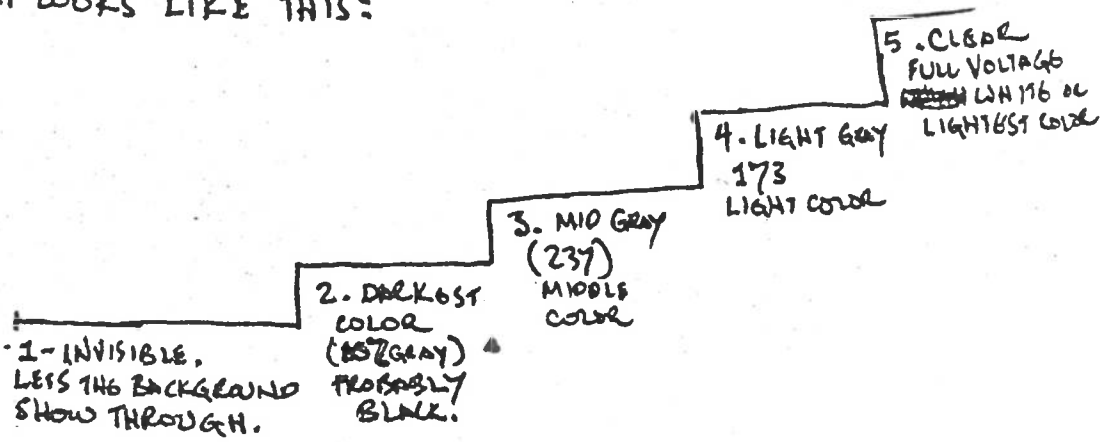
ALL WITHIN YOUR STANDARD
3x4 FORMAT!

WHOOPS-

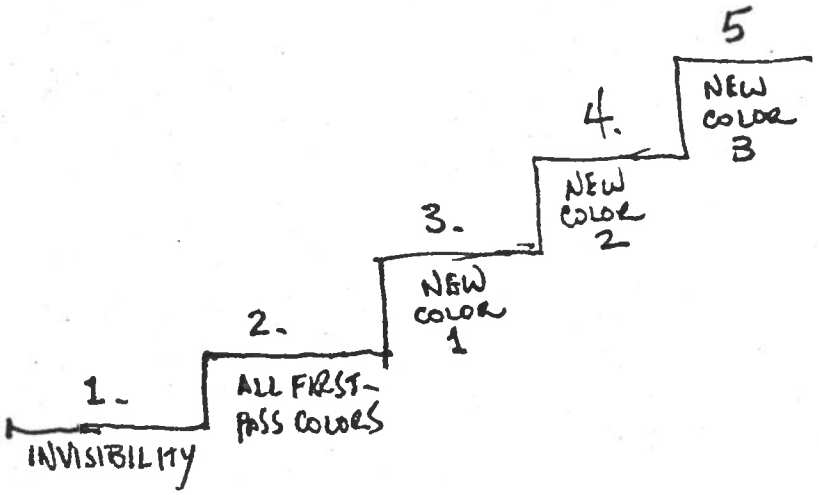
ON ADDING COLORS WITH ADDITIONAL PASSES—
IF A FIRST-PASS COLOR SECTION MUST OVERLAP A
SECOND-PASS COLOR SECTION--YOU'RE HURTING.

THE MOST ELEGANT WAY TO DO IT IS LIKE SO:

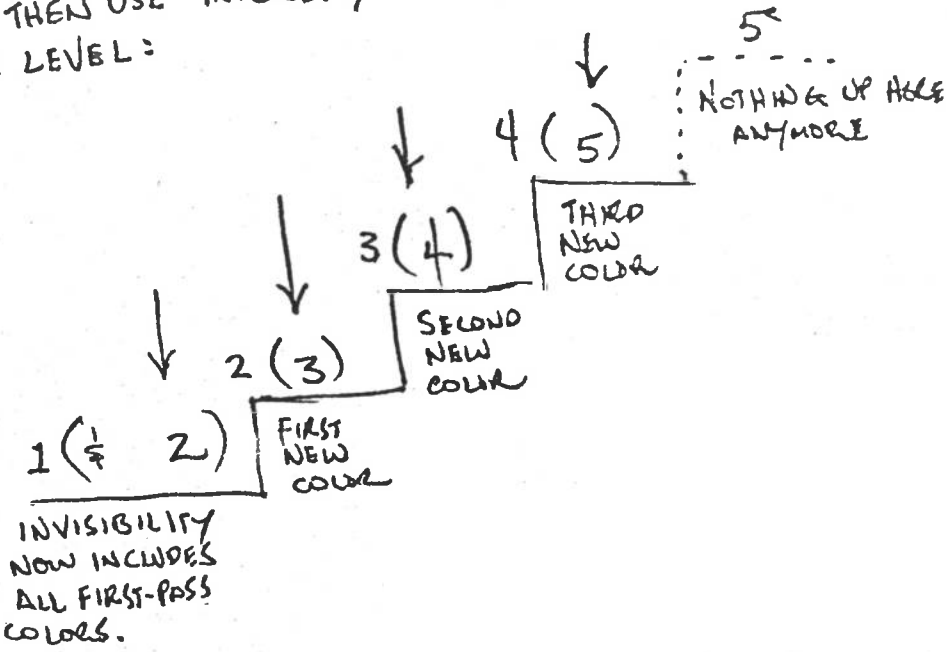
A FULL GRAY SCALE GIVES YOU A SET OF VOLTAGES
THAT LOOKS LIKE THIS:



THIS YOU PUT DOWN ON THE FIRST PASS.
SECOND PASS, YOU PUT AN OVERLAY ON YOUR FIGURE
THAT BRINGS EVERY ~~RED~~ FIRST-PASS COLOR TO LEVEL 2 – 10% GRAY.
NOW YOU HAVE:



YOU THEN USE 'INTENSITY' TO REDUCE -- DROP -- ALL SECTIONS ONE LEVEL:



HIT IT

BUT OVERLAP STILL WORKS FOR LEVEL 1 —— EVERYTHING YOU DID ON FIRST PASS WILL STAY WHERE IT BELONGS.

BUT YOU CAN NOW ADD ONLY THREE ADDITIONAL COLORS PER PASS. IT ALSO REQUIRES EXTRA ART TIME FOR APPLYING THE EXTRA GRAY SCALE.

ERGO - AVOID IF POSSIBLE.

IF, HOWEVER, THE SECOND-PASS COLORS ARE ALL ON SECOND-PASS SECTIONS ... OH, JOY INCARNATE.

MATTE THEM OUT ON FIRST PASS BY LAYING SCRAPS OF BLACK PAPER OVER THE KODALITH ON THE LIGHT BOX.

TAPE YOUR FIRST PASS.

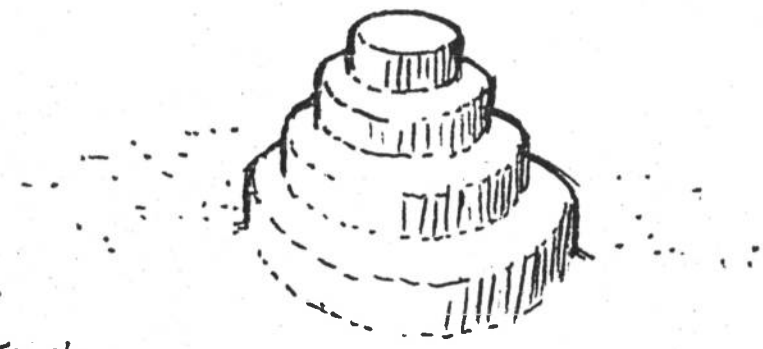
OK?

BACK TO ANIMATE, RECALL YOUR FIRST & LAST FRAMES
FUNCTION SWITCHES OFF.
CHANGE COLORS
PUT THE FEMALE MATTE OVER THE LIGHT BOX (MOVE THE PAPER SCR
TAPE YOUR SECOND PASS

....UND SO WEITER

THESE 'STEPPED' COLORS/GRAY SCALES ALSO BRING UP AN INTERESTING SITUATION:

IF YOU WERE TO MAKE A MAGNIFIED MODEL OF YOUR VIDEO PICTURE WITH THE VOLTAGE LEVELS ACTUALLY RAISED LIKE HILLS, YOU MIGHT SEE A DOT LIKE THIS:



YOU SEE, THE VOLTAGE HAS TO GO FROM THE BOTTOM LEVEL (LOWEST VOLTAGE) TO THE HIGHEST IN A TINY FRACTION OF A SECOND.... BUT AS IT CLIMBS, IT CROSSES EACH COLOR LEVEL -- WHICH IS DISPLAYED AS THAT COLOR. THE SAME THING HAPPENS AS THE ELECTRON BEAM PAINTING THE SCENE HITS THE FAR SIDE AND DROPS TO ZERO.

THE END RESULT IS A FINE -- BUT DISCERNABLE -- COLOR FRINGE. EVERY COLOR AREA IS SURROUNDED BY ONE FINE LINE OF EACH OF THE COLOR/GRAY LEVELS UNDER IT.

ERGO: THE BRIGHTEST, BOLDEST, SMEARIEST COLORS GO ON THE TOP LEVEL. RED AND WHITE LOOK BEST WITH RED AS LEVEL 5, AND WHITE AS LEVEL 4. (RED AREAS WITH A WHITE FRINGE LOOK MUCH BETTER THAN WHITE AREAS WITH A RED FRINGE.)

NOTE: YOUR OSCILLATORS ARE PRETTY STRAIGHTFORWARD UNLESS YOU WANT TO ANIMATE--MOVE--YOUR PHASE POINT DURING THE SCENE. A ONE-FRAME MOVE IS NO PROBLEM. ONE OVER SEVERAL FRAMES PROBABLY WILL BE.

CAESAR LOCATES THE PHASE POINT ON THE RASTER SECTION BY A NUMBER MAP: 01 TO 99. WHEN YOU PUSH THE SHIFT BUTTONS, HE CYCLES EASILY FROM 99 TO 01 OR BACK-- 97-98-99-01-02-03 ... 03-02-01-99-98-97... WITHOUT A HITCH. BUT, WHEN YOU ANIMATE CAESAR ALWAYS ANIMATES OVER THE LEAST DISTANCE. IF YOUR MOVE (AS SEEN ON THE LIGHTS OVER THE KEYBOARD) RUNS 01 ... 50 .... 99 .... 50 99

KEY FRAME 1 — SECOND KEY — THIRD KEY — FOURTH KEY — FIFTH KEY

.... THEN YOUR OSCILLATOR WILL ABRUPTLY TURN AROUND AND GO BACKWARDS IMMEDIATELY AFTER YOUR THIRD KEY FRAME AND WILL OBSTINATELY RESIST YOUR ATTEMPTS TO TURN IT AROUND AGAIN.

....BUT NOW YOU KNOW.

YOU'D GO INTO THE RESULTING WRECKAGE AND ON THE FIRST FRAME THAT WENT BAD, (THE FIRST ONE AFTER YOUR THIRD KEY FRAME) AND PUSH THE SHIFT BUTTON UNTIL YOUR KEY FRAMES NOW LOOK LIKE THIS:

01 ... 50 .... 99 .. 01 .... 50 99

NEW KEY FRAME = THIRD KEY FRAME PLUS ONE

.... ASSUMING, OF COURSE, THAT THE MOVE TICKED OFF AN '01' INCREMENT PER FRAME. IF IT WORKS OUT TO SAY '04' PER FRAME YOU'D ENTER THAT.... AND YOUR LAST GOOD FRAME MIGHT HAVE FALLEN SHORT OF 99, SO YOU'D HAVE TO ALLOW FOR THAT, BUT THOSE ARE THE ONLY COMPLICATIONS. YOU'VE GOT IT MASTERED NOW...

CONTROLS

SECTION LENGTH
VERTICAL AXIS
HORIZONTAL AXIS } ROTATION POINTS } SET ONCE AND GET THE HELL AWAY.

SIGNAL BLANKING START
SIGNAL BLANKING WIDTH } OCCASIONAL USE

OSCILLATOR FREQUENCY - SET & FORGET
OSCILLATOR AMPLITUDE - USE FREQUENTLY

VERTICAL SIZE
HORIZONTAL SIZE } SQUASH-STRETCH
DEPTH

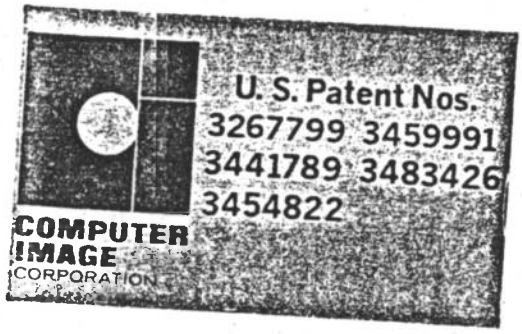
VERTICAL POSITION
HORIZONTAL POSITION } USE CONSTANTLY
ROTATION

EACH POT FUNCTION SWITCH HAS 15 POSITIONS + OFF

DAVE HOLMAN LEFT D.C. TO TUTOR
A COLORADO ANIMATING COMPUTER
BUT HIS DRAWINGS ILLICIT
WERE VERY EXPLICIT
(USING LOGARITHMIC FACTORS
TO PROPEL THE ACTORS
AND COMPUTER PROJECTIONS
TO PROGRAM ERRECTIONS
AND HUNDREDS OF DIODES
FOR A MENAGE ET TRIODES
ELECTRONIC, ERATIC
WITH SOUND MEGAPHONIC
WITH A FEEDBACK EQUATION
FOR TACTILE SENSATION.
IT'S AN OBSCENE DISPLAY
ON THE COLD CATHODE RAY)
"I'LL CALL IT", HE SAID, "DEEP COMPUTER".

CLEAR		100%
173	LT. GRAY	60%
237	MED. GRAY	30%
173+237	DARK GRAY	10% — OR ENGRAVER'S SCREEN
OPAQUE	——	0%

173+173 = 237 (60%)
173+237 = 10%



Grey Scaling

REFLECTED LIGHT VALUE

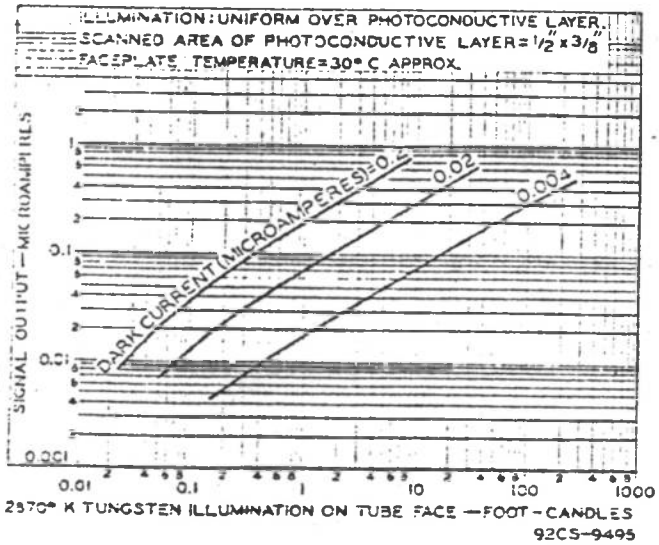
SCALE PATTERN #	D_T	R%	D_R	T%	T^2%
173	.43	25	.6	37	14
175	.61	11.5	.94	25	6.2
237	.71	9	1.05	20	4
176	.76	6.5	1.2	17.5	3.1
177	.95	4	1.4	11	1.2
236	1.59	3	1.5	2.6	.1
236+173				7.4	

10%

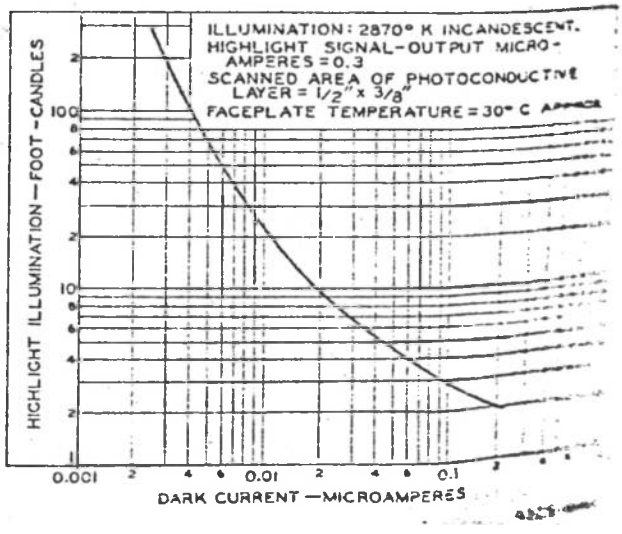
SCANNING IS DONE WITH AN RCA VICTOR 8572A VIDICON WITH AN AVERAGE GAMMA FOR LIGHT TRANSFER CHARACTERISTIC CURVES OF APPROXIMATELY 0.65, AND IS REASONABLY UNIFORM OVER A RATHER WIDE RANGE OF TARGET VOLTAGES.

THE

Light Transfer Characteristics



Typical Characteristic



CAESAR DELAY

SET SENSE SWITCH 4
PLAYBACK
[OPTION 'CHANGE SCENE]
"IS ABOVE RANGE OK?"
" ARE ABOVE DELAYS OK?
"ONE MORE TIME?"
TO CHANGE DELAYS, HIT 'INTL FR' BUTTON AT THIS POINT.

REPEATING PLAYBACKS

SET SENSE SWITCH 3

TAPTIMER

SET SENSE SWITCH 4
INSERT
'FINAL FR' BUTTON WILL RECORD TIME IN FRAMES EVERY TIME YOU HIT IT
'NO' TO STOP
TURN TTY ON.
'YES' FOR TTY PRINTOUT
'NO' FOR CRT DISPLAY... FOLLOWED BY 'YES' YIELDS PRINTOUT
'INTL FR' RESETS
'ABORT' TO GET OUT

BLANKING CONTROL

ENTER THRU 'LINEAR FAIRING'
"REFERENCE FRAME" IS THE ONE YOU ANIMATED WITH.
'INTL FR' BUTTON GIVES YOU A HYPHEN BETWEEN FRAME NUMBERS
ENTER A NONSENSE FIGURE FOR 'FRAME TO BE TRANSFERRED TO' TO GET OUT
ENTER '0' TO CLOSE LIST

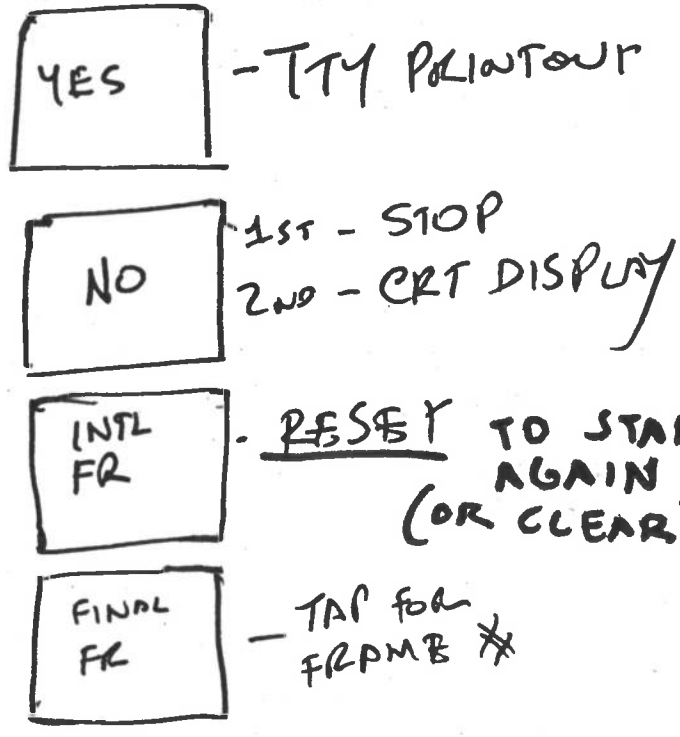
THESE PARAMETERS WILL BE ADJUSTED TO SUIT THE ANIMATION:
- BND. HORIZ. & VERTICAL
- CHAR H. & V
- ROTATION
- DEPTH
- H&V AXIS
- H&V SIZE

THESE WILL NOT:
- S.B. START & WIDTH
- INTENSITY
- AO FREQ & AMP — ???!
- SECT. LENGTH

REAL TIME OVERRIDE

'SENSE SWITCH 2
RECENTER
PLAYBACK

SET SENSE 4
"TAPTIMER/INSERT"



ABORT

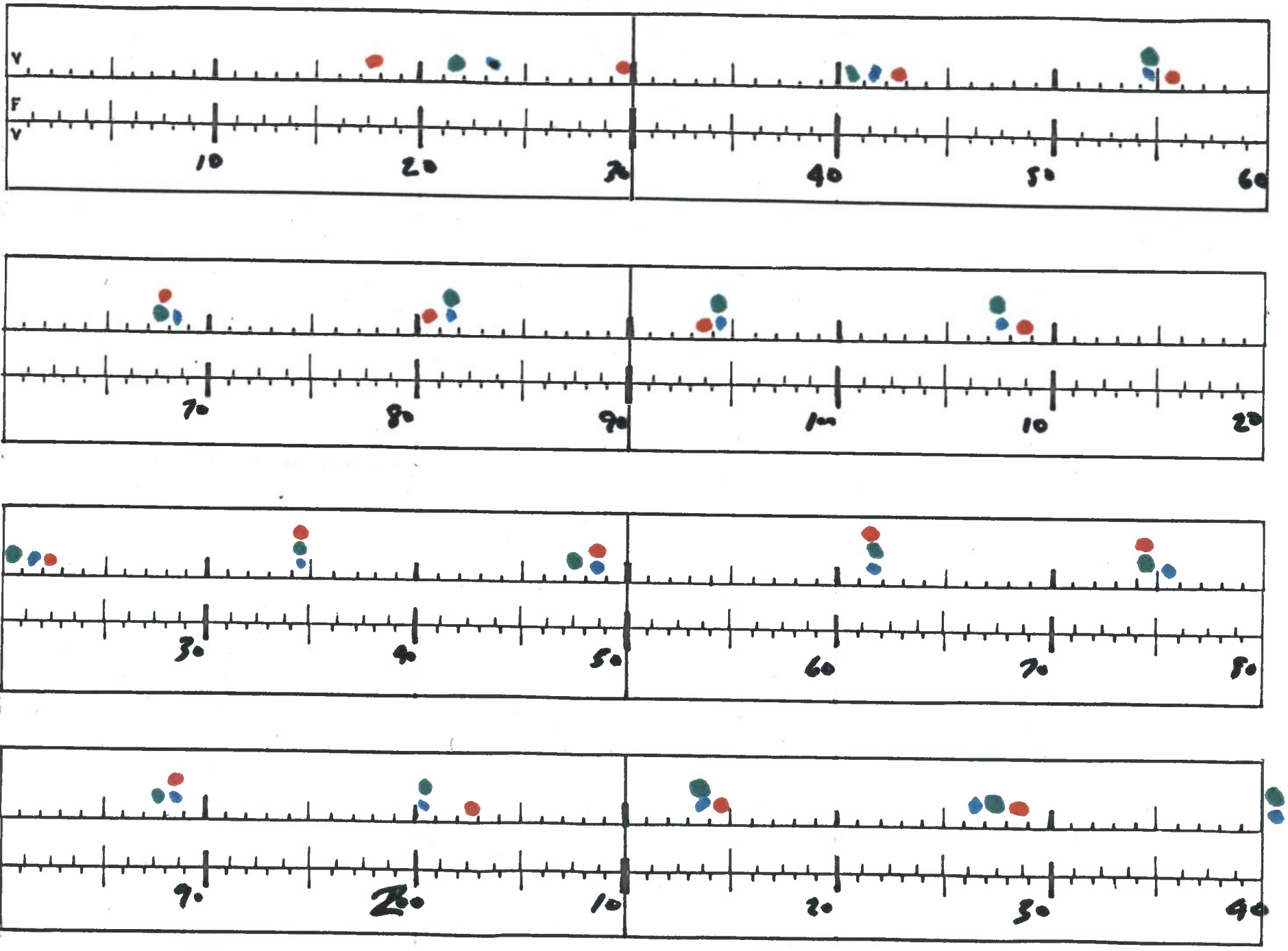
UNSET SENSE 4
TTY KNOB IN OFF (MID) POSITION
GREY KNOB
TELETYPE PRINT: COUTERCLOCKWISE *
HIT "NO" TWICE, THEN YES

COMPUTER IMAGE CORPORATION

TAP TIMING LESSON

DATE JULY 11 '78

SHEET 1 OF 1



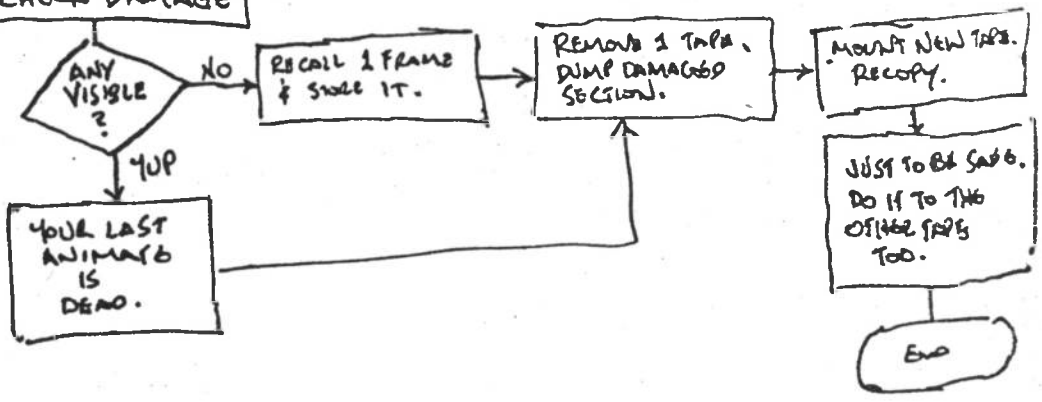
TO COPY GOOD DATA ONTO BLANK TAPE

SET TAPE UNITS: GOOD IS 'UNIT 1'
RAW STOCK IS 'UNIT 2'

TAPES AT 'LOAD' AND 'ON LINE'
SI
MASTER CLEAR
P/Y
21,206*
RUN
START
YOU NOW SHOULD SEE ALL 8 PROGRAM 'BLOCKS' COPIED IN 8 MOVES FROM UNIT 1 TO UNIT 2 – MOVEMENTS SHOULD BE OF EQUAL LENGTH. UNIT 2 LAGGING.
DO NOT TOUCH TAPES

SI
MASTER CLEAR
P/Y [YOU SHOULD STILL BE HERE]
21,206*
RUN
START
YOU HAVE COPIED PROGRAMS & ANIMATION

— IF YOU GET A HALT AT 16,300* or 16,101*
THE TAPE IS GETTING WEAK. GO THROUGH THIS ROUTINE.
(AFTER YOU CHECK FOR MECHANICAL DAMAGE TO TAPES.)
-- THAT IS: CHECK DAMAGE



RELOAD SYSTEMS TAPE

COLD START

TURN ON POWER SWITCHES FROM RIGHT TO LEFT.
CLEAN HEADS & ROLLERS ON TAPE MACHINES & LOAD TAPES [READ 'LOAD' & 'ON LINE']
SET 'UNIT 1' TO 'UNIT 3'
SENSE SWITCHES OFF!
MA
P
STORE
MASTER CLEAR
P/Y
20*
M
'1' [LOOKS LIKE 100,000* — MEANS 'READ']
15,000* [LOOKS LIKE 115,000*]
START
P+1
CLEAR [NOT MASTER CLEAR]
27,777* [MEANS LOAD ALL OF CORE]
START
P/Y -- SHOULD SEE 21*
CLEAR
1*
RUN
START [LOAD ALL REMAINING?] SEE '13*' - 11* IS 'BAD READ'
SET TAPE UNITS TO 1 & 2
GO TO 'RESTART'

RETURN UNIT 3 TO LOAD POINT

FETCH.

RESTART

SI
MASTER CLEAR
16,00[illegible]*
RUN
START

"REAL-TIME OVERRIDE" ALLOWS YOU TO DRIVE UP TO SIX PARAMETERS DURING PLAYBACK FROM AN OUTSIDE SOURCE... SUCH AS SCANIMATE, YOUR CONTROL KNOBS (LIMIT: 3) OR SENSORS FESTOONED ON A DANCER, ETC.

TO USE: SET SENSE SWITCH 2, GO TO PLAYBACK
RECENTER SWITCH IN OPERATE
ENTER 251 IN UNUSED CHANNELS

FUNCTION	SECTION 1	2	3	4	5	6	7	8
CHR X	15	45	75	105	135	165	195	225
CHR Y	16	46	76	106	136	166	196	226
X DEPTH	17	47	77	107	137	167	197	227
Y DEPTH	21	51	81	111	141	171	201	231
H POS	19	49	79	109	139	169	199	229
V POS	20	50	80	110	140	170	200	230
H AXIS	24	54	84	114	144	174	204	234
V AXIS	25	55	85	115	145	175	205	235
H SIZE	26	56	86	116	146	176	206	236
V SIZE	27	57	87	117	147	177	207	237
INTEN	28	58	88	118	148	178	208	238
START BLK	43	73	103	133	163	193	223	253
BLNK WIDTH	44	74	104	134	164	194	224	254
H OSC. AMP	39	69	99	129	159	189	219	249
H OSC FREQ	32	62	92	122	152	182	212	242
V OSC AMP	35	65	95	125	155	185	215	245
V OSC FREQ	36	66	96	126	156	186	216	246
D OSC. AMP.	31	61	91	121	151	181	211	241
D OSC FREQ	40	70	100	130	160	190	220	250

ENTER CODE FOR SECTION AND FUNCTION.
ENTER 251 FOR EMPTY CHANNELS.

OPERATING SWITCHES FOR EXTERNAL INPUTS ARE IN UPPER LEFT CORNER OF CPU PANEL. DON'T LEAVE THEM IN 'EXT' POSITION WHEN YOU ARE DONE OR SOME PARAMETER WILL NOT RESPOND TO YOUR NORMAL CONTROLS.

LIST 1

H316 OUTPUTS TO CAESAR

DIGITAL CH. NO.	
0	GREY LEVEL 1 - RED
1	GREY LEVEL 1 - GREEN
2	GREY LEVEL 1 - BLUE
⋮	⋮
12	GREY LEVEL 5 - RED
13	GREY LEVEL 5 - GREEN
14	GREY LEVEL 5 - BLUE

10 BIT D-A

THE GREY LEVEL OUTPUTS WILL BE 0 TO +10 VOLTS OUT. DUE TO THE SCAN CONVERSION PRIOR TO GREY-LEVEL COLORING, SECTION INFORMATION IS LOST AND THESE CHANNELS WILL BE UPDATED ONCE PER FIELD DURING THE VERTICAL RESET INTERVAL.

(TRIED full color VIA the H-316 ON 5-6 NOV. & IT looks great!)

Marsh

H316 OUTPUTS TO CAESAR

DIGITAL CH. No.	
15	OVERALL X POSITION 12 BIT D-A
16	OVERALL Y POSITION 12 BIT D-A
17	OVERALL DEPTH 12 BIT D-A -10 VOLTS TO +10 VOLTS
	CH.'s 15, 16, 17 WILL INITIALLY BE UPDATED ONCE PER FIELD FRAME. IF IT IS DETERMINED THAT A NEED TO UPDATE ON A SECTION BASIS EXISTS, IT WILL MEAN ONLY A CHANGE TO THE H-316 PROGRAM.
18	SECTION LENGTH. THIS CHANNEL WILL BE A PRESETTABLE BINARY COUNTER. THE COUNTER WILL COUNT HORIZ. RESET PULSES. COUNTER OVERFLOW WILL SEND A PULSE TO THE SYNTHESIZERS, C.P.U., AND MAIN CONTROL OF THE H-316 OUTPUT CIRCUITS. UPDATE BY THE H-316 WILL OCCUR AFTER COUNTER OVERFLOW AND ON VERTICAL RESET. UPDATE WILL BE FAST ENOUGH SO

H316 OUTPUTS TO CAESAR

DIGITAL CH. No.	THE REMAINING CHANNELS WILL BE UPDATED EA. SECTION
19	HORIZ. POSITION 12 BIT D-A
20	VERT. POSITION 12 BIT D-A
21	DEPTH. 12 BIT D-A -10V TO +10V
	ROTATION
22	SIN (θ) 12 BIT D-A
23	COS (θ) 12 BIT D-A 20 VOLTS PEAK TO PEAK (-10V TO +10V)
24	HORIZ. CENTER OF ROTATION
25	VERT. CENTER OF ROTATION 12 BIT D-A -10V TO +10 V.
26	HORIZ. SIZE 12 BIT D-A
27	VERTICAL SIZE 12 BIT D-A -10V TO +10 V
28	INTENSITY PRIOR TO COLORING 10 BIT D-A -10V TO +10V. CHANGES INTENSITY ON A SECTION BASIS PRIOR TO SCAN CONVERSION.

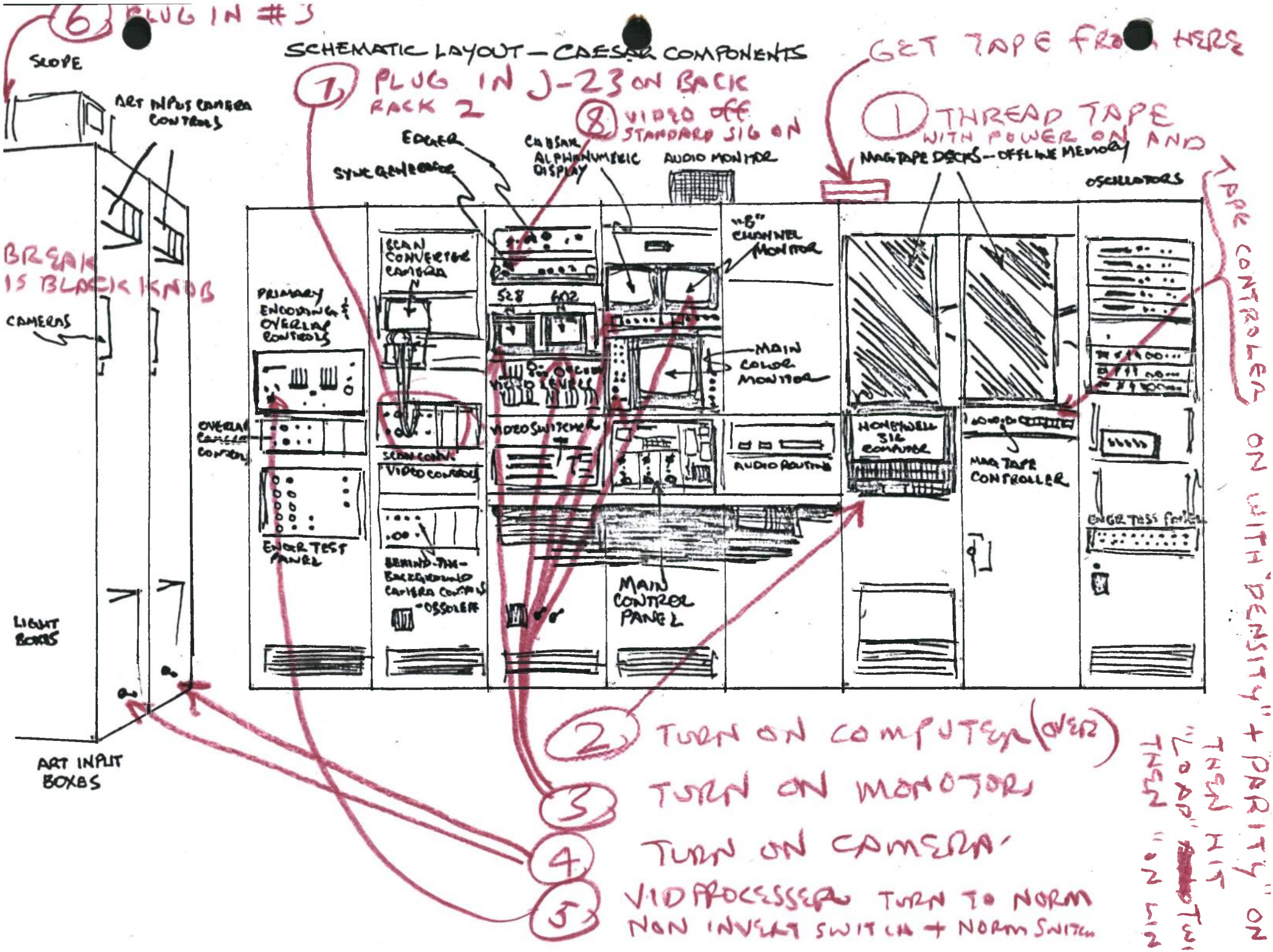
H316 OUTPUTS TO CAESAR

DIGITAL CH. NO.	
29	DIGITAL CONTROL 16 BITS
30	DIGITAL CONTROL 16 BITS
	32 SEPERATE LINES AVAILABLE FOR SECTION BLANKING, VIDEO SWITCHING, ANIMAC/SCANIMATE CONTROL, ETC.
	ANIMATION OSCILLATORS (FREQ. SYNTHESIZERS)
31	HORIZ. ANIMATION AMPLITUDE 10 BIT D-A (-10)
32	HORIZ. ANIMATION - FREQUENCY 3 MOST SIGNIFICANT DECADES
33	HORIZ. ANIMATION - FREQUENCY 4 LEAST SIGNIFICANT DECADES
34	HORIZ. ANIMATION PHASE/CONTROL
	CH. 31 WILL BE 0 TO +10 VOLTS (-10 TO +10 VOLTS)
	CH's 32, 33 WILL BE B.C.D. INFO CONTROLLING THE 7 DECADES OF FREQ. — OUT PUT TO THE SYNTHESIZER WILL BE SERIAL, 28 BITS @ 2 MHZ. RATE

NOTE: These oscillators MAY feed other INPUTS than those MENTIONED

H316 OUTPUTS TO CAESAR

DIGITAL CH. No.	
	CH 34 WILL CONTAIN BINARY PHASE INFORMATION (10 BITS) PHASE SHIFTS OF 0 TO 360° WILL BE OBTAINABLE. IN ADDITION THERE WILL BE 4 BITS DECODED TO PROVIDE 1. SINE WAVE ∿ 2. TRIANGLE WAVE ⩘ 3. RAMP ⩘⩘ 4. SQUARE WAVE ⎍⎍ 5. HIGH FREQ. UPPER LIMIT 0-100 KHZ Δf = .01 HZ MINIMUM PHASE SHIFT 3.6° 6. LOW FREQ. UPPER LIMIT 0-10 KHZ Δf = .001 HZ MINIMUM PHASE SHIFT 0.36° 7. PHASE LOCK - SYNC TO HORIZ. RESET 8. NO PHASE LOCK-


6 PLUG IN #3
SCHEMATIC LAYOUT — CAESAR COMPONENTS
GET TAPE FROM HERE
1 PLUG IN J-23 ON BACK RACK 2
8 VIDEO OFF STANDARD SIG ON
1 THREAD TAPE WITH POWER ON AND
SLOPE
ART INPUT CAMERA CONTROLS
EDGER
SYNC GENERATOR
CAESAR ALPHANUMERIC DISPLAY
AUDIO MONITOR
MAG TAPE DECKS — OFFLINE MEMORY
OSCILLOSCOPES
TAPE CONTROLLER ON WITH "DENSITY" + "PARITY" ON
THEN HIT "LOAD" TWICE
THEN "ON LINE"
BREAK IS BLACK KNOB
CAMERAS
PRIMARY ENCODING & OVERLAY CONTROLS
SCAN CONVERTER CAMERA
"B" CHANNEL MONITOR
528
602
MAIN COLOR MONITOR
VIDEO SWITCHER
AUDIO ROUTING
HONEYWELL 316 COMPUTER
MAG TAPE CONTROLLER
ENCODER TEST PANEL
SCAN CONV. VIDEO CONTROLS
BEHIND-THE-BACKGROUND CAMERA CONTROLS - OBSOLETE
MAIN CONTROL PANEL
LIGHT BOXES
ART INPUT BOXES
2 TURN ON COMPUTER (over)
3 TURN ON MONITORS
4 TURN ON CAMERA
5 VID PROCESSERS TURN TO NORM
NON INVERT SWITCH + NORM SWITCH

4 2 1

N 316

S1

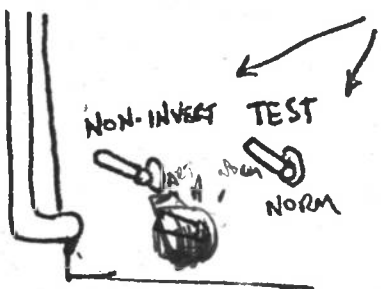
MSTR CLEAR "CLEAR"

4, 5, 6, 16 (16001)

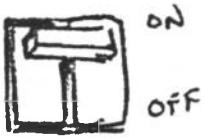
SEARCH TAPE

FIRING UP CAESAR:

FIRST: BEFORE YOU TURN HIM ON —



PLUG IN ANY DISCONNECTED LINE CORDS.
POWER SWITCHES ARE LOW ON THE CONSOLE FRONTS
TURN THEM ON (UP) FROM RIGHT TO LEFT.
THERE ARE A COUPLE OF BALLRAT SWITCHES @ DOWN THERE ALSO
TURN THEM ON TOO, AS YOU COME TO THEM.



THREAD UP THE TWO TAPE DECKS WITH
A "CAESAR SYSTEMS" TAPE EACH
(THREADING DIAGRAM IS ON THE DECK,
TAPES ARE ON THE RIGHT-HAND SIDE OF
THE RACK ATOP THE TWO TAPE DECKS)
CHECK TO SEE THAT POWER IS ON BOTH DECKS
AND ON THE CONTROLLER (THE SMALL CONSOLE
UNDER THE RIGHT DECK.)
HIT "LOAD" TWICE - FIRST TO TENSION, THEN ADVANCE THE TAPE.
HIT "ON LINE"
SIT DOWN AT THE COMPUTER (the "316")

SWITCH ONE TAPE TO "UNIT 3", THE OTHER TO "UNIT 2"
PUNCH 'MA'
'P'
'STORE'
'MASTER CLEAR'
'P/Y'
'20' ← LOOKS LIKE THIS
'M'
'1 1 5 000'
'START'
'CLEAR' (NOT MASTER CLEAR)
'P+1'
'2 7777'
'START'
'P/Y' — YOU SHOULD SEE '21'
'CLEAR'
'1'
CHECK 'UNIT 3' AND IF IT HAS MOVED, HIT 'ON LINE' 'REWIND' 'ON LINE'
'RUN'
'START' —

USUALLY NOT NECESSARY FROM STANDOUT

- OVER -

YOU SHOULD SEE '13'
'11'
- IS A "BAD READ." DO IT AGAIN.

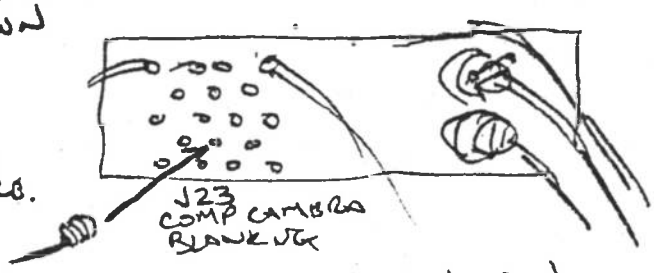
'FETCH'
CHANGE 'UNIT 3' TO 'UNIT 1'

'SI'
'MASTER CLEAR'
'16,000'
'RUN'
'START'
CAESAR WILL GO INTO 'ANIMATE' MODE AND AWAIT YOUR INSTRUCTIONS.
TURN ON ALL THE MONITORS, INCLUDING THE ONE ON TOP THE LEFT END PANEL RACK.
TURN ON THE LIGHT BOXES IN THE ~~HURT~~ ART INPUT CABINETS.

ON THE BACK OF THAT CABINET ARE FIVE CABLE CONNECTIONS.
IF CAESAR HAS BEEN LEFT ON 'STANDBY' ALL NIGHT, THE MIDDLE CABLE WILL BE -- SHOULD BE -- DISCONNECTED
PLUG IT BACK IN.

IF IT'S DISCONNECTED, THERE WILL BE ANOTHER UNPLUGGED BEHIND CAESAR.
GO AROUND VIA THE BACK DOOR — DON'T ATTEMPT TO SQUEEZE THROUGH THE TANGLE OF CABLES AND LINE CORDS.
YOU COULD BE ALL DAY FINDING WHICH CONNECTION YOU PULLED LOOSE.

GO TO THE SECOND RACK FROM THE RIGHT (SEEN FROM BEHIND)
KNEEL DOWN



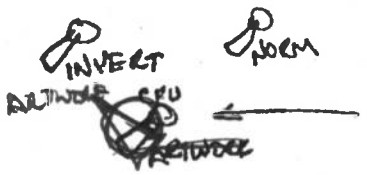
IF THE CABLES TOTALLY LOST IN THE CONFUSION, THE OTHER END SHOULD BE ATTACHED ONE RACK FURTHER LEFT — ON THE LOWER LEFT CONNECTOR MARKED 'CAM BLKG A OUT'.

COME ON OUT FRONT AGAIN.
CAESAR IS NOW ON LINE AND READY TO RUN.

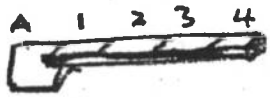
PUTTING ARTWORK INTO THE MACHINE.

PUT THE KODALITH ONTO A LIGHT BOX. TURN ON THE LIGHT AND UNCAP THE LENS.

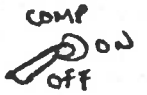
SET:



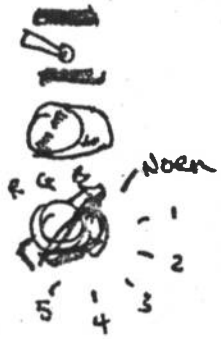
← IF THERE'S AN ANIMATED FRAME ON SCREEN — OTHERWISE IT DOESN'T MATTER



← GO INTO ANALOG



← TURN OVERLAP OFF



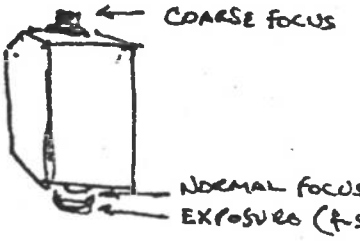
AND SET THIS —

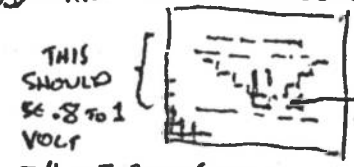
TO LOOK AT THE CAMERA THE ART IS ON.

MOVE THE CAMERA UNTIL ALL THE SECTIONS FIT IN THE RECTANGLE OF LIGHT. TURN 'INVERT' SWITCH TO 'NON-INVERT'

TAKE THE ARTWORK OFF THE LIGHT BOX AND PUT THE RESOLUTION CHART ON.

USE THE SCOPE TO FOCUS — THE ONE THAT LIVES ON TOP OF CAESAR





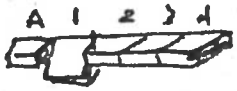
← WHEN THIS CENTRAL BAR REACHES ITS LOWEST POINT, YOU HAVE YOUR BEST POSSIBLE FOCUS

TAKE THE TEST CHART OFF, PUT YOUR KODALITH BACK ON AND CLOSE THE CABINET. IT'S SET.

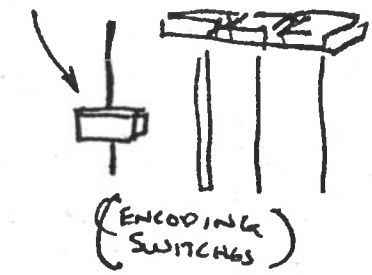
GO INTO 'ANIMATE' IF YOU AREN'T ALREADY.

HIT 'CH SC' — CAESAR ASKS "USE THIS FRAME?"
AND AN EMPTY SCENE NUMBER.

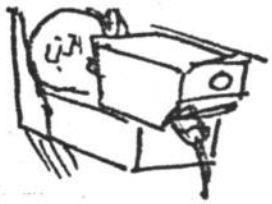
SET:



AND THIS



UNTIL THE DARKEST GRAY ON YOUR ART STARTS TO BREAK UP ON THE SCAN CONVERTER SCOPE.

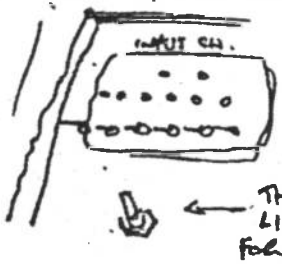


AND HIT "NO"

CAESAR WILL TRY TO AUTOMATICALLY SECTION THE KORALITH.

IF IT WORKS:

THE PICTURE WILL GIVE A FUNNY FLIP, STABILIZE, AND CAESAR WILL SHOW KEY FRAME 1 AS FRAME 0001.



← THIS SWITCH WILL LIGHT ROTATION POINTS FOR EACH SECTION on SCOPE AND SCREEN.

THERE SHOULD BE ONE POINT FOR EACH SECTION, CENTERED ON IT. IF NOT — TRY AGAIN. DO THIS PAGE OVER.

IF IT'S READING TWO SECTIONS AS ONE OR ONE AS TWO, USE THAT ADJUSTING LEVER TO TRY AND CLEAR UP THE CONFUSION. IF IT WON'T GO — GO TO THE "IF IT DOESN'T" OVER HERE.

IF IT WILL, SHUT OFF THE ROTATION POINT LIGHTS AND LET'S GET ON WITH IT.

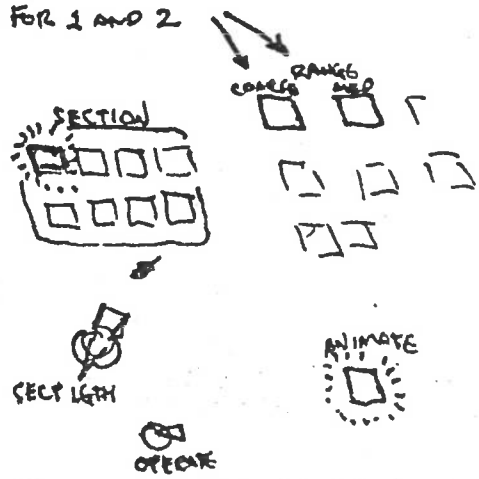
IF IT DOESN'T: C. SAYS "ENTER NUMBER OF SECTIONS"

SWEAR LOUDLY
(SOFTLY IF LADIES ARE PRESENT)
FOR THE GOOD OF YOUR SOUL

ENTER THE NUMBER.
CH SC — SAME SCENE NUMBER —
"USE THIS FRAME?" — TRY IT AGAIN. THE WHOLE PAGE WORTH OF INSTRUCTIONS.
STILL WON'T WORK?

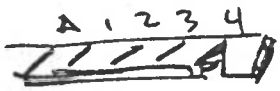
SET THE CORNER SWITCHES TO 'INVERT' AND 'ARTWORK'.

FUNCTION SWITCH TO 'SECT LGTH'
LIGHT SECTION 1's BUTTON
LOOK AT THE SCAN CONVERTER SCOPE — IT'S DIFFICULT
AND USE THESE BUTTONS TO MOVE SECTION 1's LINE BETWEEN THE PIECES FOR 1 AND 2

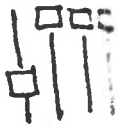


THEN SHUT OFF SEC 1's LIGHT, HIT SEC 2 AND REPEAT UNTIL ALL SECTION LINES FIT. (THERE WILL BE ONE LESS LINE THAN YOU HAVE SECTIONS.) SHUT OFF 'ANIMATE' FUNCTION SWITCH OFF, AND LET'S ANIMATE!

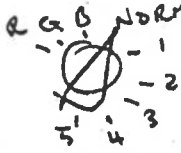
SET THE SWITCH FOR THE NUMBER OF GRAY LEVELS YOU'RE USING.



AND USE THE KNOBS LEFT TO RIGHT, BRINGING THEM DOWN FROM THE TOP, TO IDENTIFY THE GRAY LEVELS ONE BY ONE.



YOU CAN SET THE SWITCH TO LOOK AT ONE LEVEL AT A TIME



'1' SHOULD SHOW THE AREA SURROUNDING YOUR ARTWORK AS A CLEAN LIGHT AREA AND THE ART AS A CLEAR DARK

'2' SHOULD SHOW ALL YOUR DARKEST GRAY AREAS AS LIGHT ON A CLEAR DARK FIELD.

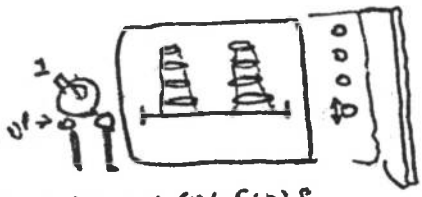
3 - YOUR MIDDLE GRAYS
4 - YOUR LIGHTEST GRAYS
5 - CLEAR AREAS

(YOU MAY USE FEWER GRAYS - NO MATTER. JUST KEEP THEM CLEAN AND ON DIFFERENT, DISTINCT LEVELS.)

GO BACK TO 'NORM'
CORNER SWITCHES TO 'CPU', 'NON-INVERT', 'NORM'

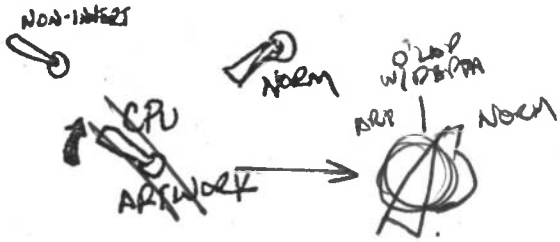
AND LOOK AT THE SLOPE

YOU SHOULD SEE A DISTINCT 'LEVEL' FOR EACH GRAY YOU HAVE — FLAT, AND REACHING FROM 7.5 TO NOMR 100 ON THE SCALE



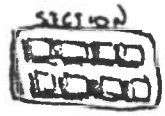
USE ↕ POS TO SET THE 7.5 AND OPEN THE LENS ON THE SLOW CONVERTER CAMERA TO GET A ROUGH LEVEL.

~~SIT DOWN AT THE CONTROLS.~~

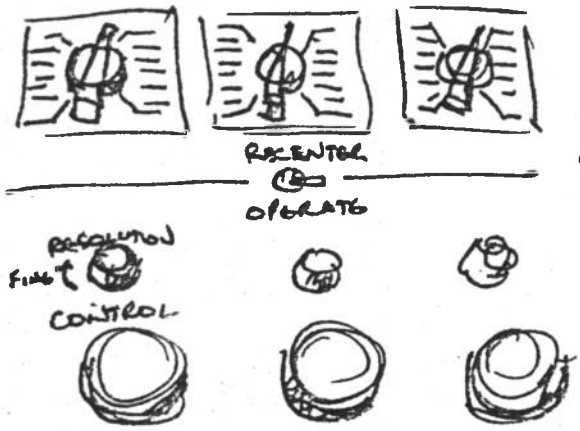


AND SIT DOWN AT THE CONTROLS

THE SECTIONS ARE IN FRONT OF YOU ON THE SCREEN.
FOR NOW, YOU'LL WORK WITH THE SECTION LIGHTS:



FUNCTION SWITCHES:



AND THE 'POTS.'

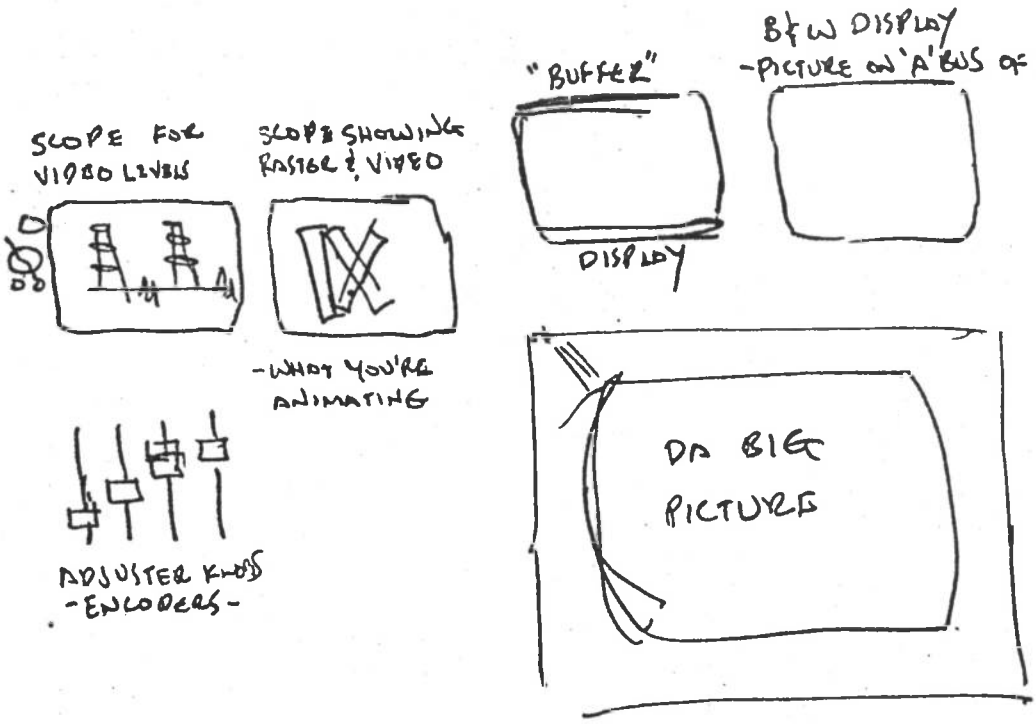
WHEN YOU SET A 'PARAMETER' — LIKE "INDIVIDUAL HORIZONTAL POSITION" ON A FUNCTION SWITCH - AND LIGHT UP A SECTION (OR TWO OR MORE) AND TURN ON ON THE 'ANIMATE' LIGHT — YOU CAN CONTROL THAT PARAMETER BY TURNING THE KNOB UNDER THAT SWITCH. (IT'LL MOVE THAT SECTION LEFT OR RIGHT ON THE SCREEN.) WHEN THE KNOB IS TURNED AS FAR AS IT WILL GO, FLIP THE 'RECENTER' SWITCH UP, MOVE THE KNOB, AND FLIP IT DOWN AGAIN. AND YOU CAN KEEP GOING. IF YOU WANT THE KNOBS TO MOVE THINGS FASTER AND FARTHER OR SLOWER AND FINER, FLIP 'RECENTER', TURN THE RESOLUTION KNOB FOR THAT KNOB TOWARD 'FINE' TO SLOW IT DOWN OR AWAY TO SPEED IT UP — DON'T FORGET TO FLIP 'RECENTER' BACK TO 'OPERATE' AFTERWARDS.

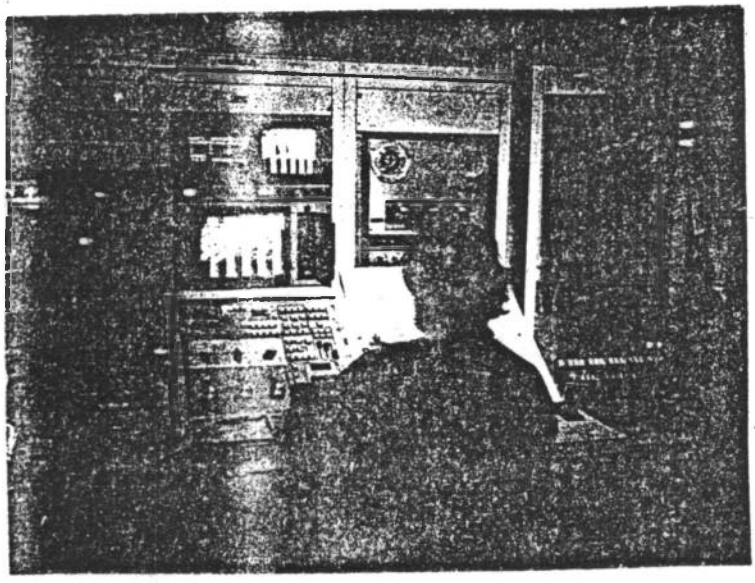
WITH THESE, YOU CAN NOW MOVE THE SECTIONS ALL AROUND THE SCREEN.

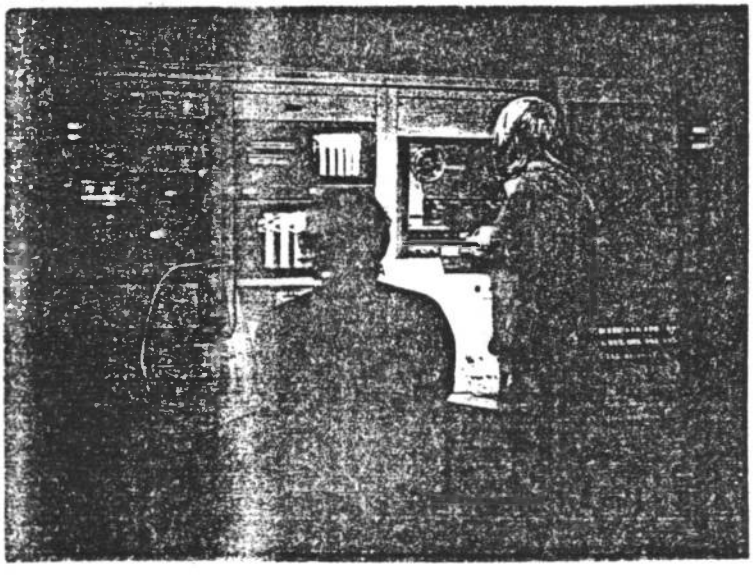
SO LET'S BUILD "FRAME ONE"

FIRST: HIT "KEEP IT" AND WATCH CAESAR PUT THIS FRAME ON TAPE.
NOW YOU HAVE A 'PERMANENT' RECORD OF WHERE THE SECTION LINES ARE. NOW THE 'BUFFER' (TEMPORARY WORKING MEMORY) SAYS YOU'RE IN 'ANIMATE' MODE WITH NO KEY FRAMES UP.
HIT 'RECALL' AND USE THE KEYBOARD TO ENTER '1' AND 'STORE'.
KEY FRAME 1 WILL SHOW 'FRAME 0001' AGAIN.

NOW TO WORK.


SCOPE FOR VIDEO LEVELS
SCOPE SHOWING RASTER & VIDEO
-WHAT YOU'RE ANIMATING
"BUFFER"
DISPLAY
B&W DISPLAY
-PICTURE ON A BUS OF SWITCH
ADJUSTER KNOBS
-ENCODERS-
DA BIG PICTURE





YOU CAN START ANIMATING RIGHT AWAY.

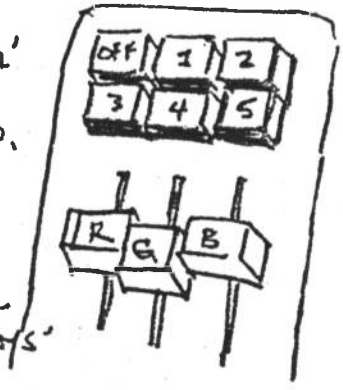
BUT I PREFER TO RUN THROUGH A ROUTINE TO SET UP THE SECTIONS AND SOLVE A BUNCH OF PROBLEMS BEFORE THEY HAPPEN:

FIRST - SWITCHES TO 'CHR H. POS - CHR V. POS - DEPTH'
LIGHT ALL SECTIONS - HIT 'ANIMATE'
USE DEPTH TO TAKE ALL SECTIONS TO A DOT. THIS IS YOUR VANISHING POINT. PUT IT WHEREVER IT'S NEEDED, OR CENTER IT IF YOU DON'T HAVE A SPECIFIC ONE. BRING THEM BACK UP TO ABOUT THE SIZE YOU NEED.

SECOND - IF YOU CAN'T SEE ANYTHING —
- 'OFF' 'OFF' 'INTENSITY' - ALL SECTIONS -
KEEP AN EYE ON THE SCOPE AND MAKE THE VIDEO ABOUT 100 TOPS - USE THE ADJUSTOR KNOBS UNDER THE LEVELS SCOPE TO CLEAN UP THE BIG PICTURE.
THEY WORK JUST LIKE THE ENCODING SWITCHES YOU USED EARLIER ON THE GRAY LEVELS, EXCEPT YOU CAN'T SEE THEM SEPARATELY.
. DON'T FIGHT IT TOO HARD YET — 'OVERLAP' WILL PROBABLY BOLLIX IT WHEN WE TURN IT ON.

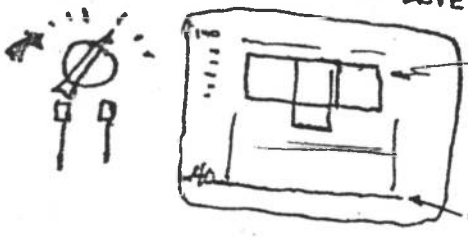
SET COLORS

. BY LIGHTING A 'LEVEL' LIGHT →
1 IS YOUR BACKGROUND,
2 YOUR DARK GRAY,
3 YOUR MIDDLE
4 YOUR LIGHT
5 CLEAR
HIT 'ANIMATE'
... AND USING THE COLOR KNOBS TO PAINT THE GREYS' APPROPRIATE COLORS.



IF YOU HAVE FEWER COLORS, SET THEM FROM LOWEST TO HIGHEST. ONCE YOUR TOP VALUE COLOR IS SET, PUNCH ALL THE BUTTONS ABOVE IT TO MAKE THEM THE SAME.

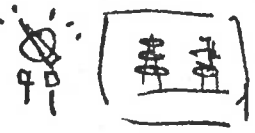
NOTE: IF YOU LIGHT A SECTION LIGHT (TURN FUNCTION SWITCHES OFF FIRST) YOU'LL SEE NUMBER VALUES FOR RED, GREEN AND BLUE ON THE BUFFER DISPLAY. IF YOU'LL NEED THE COLOR ANOTHER TIME -- WRITE THOSE DOWN.
THEN LOOK AT THE VIDEO LEVEL SCOPE.



→ YOU'LL SEE YOUR COLORS AS BLOCKS ON THE SCREEN. THE TOP OF THE BLOCK SHOULD NOT GO OVER 100 AND THE NARROWER AND HIGHER THE BLOCK IS, THE HARDER IT IS TO BAND THAT COLOR.

BASE AT - 40

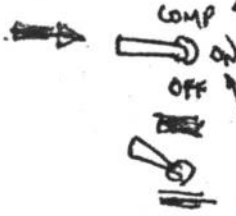
YOU CAN MOVE THE BLOCK'S TOP WITH 'GAIN' OR 'MIX'
AND ITS BOTTOM WITH 'PEDESTAL' (THE BOTTOM 'BLACK' LINE SHOULD FALL RIGHT ABOUT THE 0 AND 7.5 LINE) BUT MAINLY USE THE COLOR KNOBS NOW.
WRITE DOWN WHERE THE BOTTOM AND TOP OF EACH COLOR FALL ON THE SCOPE'S SCALE AND YOU'VE DONE ALL YOU CAN TOWARD KEEPING A RECORD OF THE COLORS.

FLIP THE VIDEO DISPLAY SCOPE BACK  AND LOOK AT YOUR INTENSITIES.

USE 'INTENSITY' AS BEFORE TO LEVEL THEM.
IF THEY ARE BOWED UPWARD ⌒, CLOSE THE LENS A STOP,
AND TURN THE CRT BIAS TO OPEN THEM OUT A LITTLE.

YOU SHOULD HAVE A 'BACKGROUND LEVEL' AT 7.5 AND ONE LEVEL ABOVE THAT FOR EACH GRAY LEVEL YOU USED ON THE ART. THEY SHOULDN'T TOP 100 ON THE SCALE. YES, YOU HAVE ONE EXTRA LEVEL — THAT'S WHERE TWO SECTIONS OVERLAP AND ADD THEIR INTENSITIES. AND IT DOES RUN OVER 100. SO...

TURN ON OVERLAP



← THIS ALLOWS COMPUTER CONTROL OF OVERLAP. IF YOU USE IT, YOU MUST LIGHT THE SECTIONS YOU WANT TO HAVE OVERLAP, LIGHT 'ANIMATE' AND HIT THE 'OVERLAP' BUTTON (UPPER RIGHT CORNER GROUP ON CONTROL PANEL) PUSHING THE BUTTON AGAIN WILL TURN IT OFF AGAIN, SO FEEL FREE TO EXPERIMENT.

← THIS IS 'NORMAL' — ALL SECTIONS ON.

...AND SWEAR.
IT HASN'T WARMED UP YET AND THE DISASTER YOU SEE IS NORMAL.
THE BRIGHT AREAS SHOW WHERE TWO SECTIONS ARE STILL OVERLAPPING
AND THE HOLES SHOW WHERE THE OVERLAP 'KEY' IS MISREGISTERED.
TURN THE CHROME KNOB UNTIL YOU'VE MINIMIZED THE DAMAGE.
THERE'S MORE WE CAN DO, BUT IT WILL DRIFT WHILE WE'RE WORKING,
SO WE'LL LEAVE IT AT THIS FOR NOW.

YOU MAY WANT TO TRY THIS TRICK: TURN OVERLAP "OFF" (ACTUALLY, IT'S ON STANDBY) AND TURN THAT LEVEL SWITCH to — THIS WILL SHOW YOU YOUR DARKEST GRAYS, LIKE A PENCIL OUTLINE DRAWING.

THIS IS ANOTHER GOOD SPOT TO HIT 'KEEP IT'
THEN RECALL FRAME 1.

NEXT- DO YOU HAVE ANY SECTIONS THAT USE TWO OR MORE PIECES OF ARTWORK (SIX MOUTH POSITIONS, A COUPLE OF LEGS, OR SOME SUCH) THAT WILL BE SUBSTITUTED DURING THE ANIMATION?

IF SO:

LIGHT THAT SECTION LIGHT.
SET 'H. AXIS' 'S.B. START' 'S.B. WIDTH'
'ANIMATE'
'SP BLK' (SPECIAL BLANKING - IT'S IN THE UPPER RIGHT-HAND CLUSTER)

CRANK 'S.B. WIDTH' UNTIL MOST OF THE ART DISAPPEARS FROM THE BOTTOM UP.

CRANK 'SB START' AND EVERYTHING SHOULD LEAP UPWARD FROM BEHIND THE INVISIBLE CURTAIN TOWARD THE TOP OF THE SCREEN. IF NOT, HIT 'SP BLK' AGAIN -- IT DIDN'T TAKE.

USE H. AXIS TO BRING IT BACK DOWN.

AS 'S.B. START' PUSHES THE ART UP, IT DISAPPEARS 'BEHIND' A SORT OF 'FIXED WINDOW FRAME'.

MOVE A PIECE OF ART UP UNTIL THE TOP LOOKS GOOD - SNUG, BUT NOT CLIPPED.

THEN USE 'SB WIDTH' TO CLOSE THE BOTTOM OF THE 'WINDOW' UNTIL THE ART LOOKS GOOD.

NOTE: 'ORDINARY BLANKING' JUST 'MOVES THE WINDOW' OVER THE ART -

NOW 'SB START' WILL MOVE THE ART 'BEHIND THE WINDOW' WITH ONLY MINOR ADJUSTMENTS ON 'SB WIDTH' NEEDED.

WE'LL DO MORE ON THIS IN A MINUTE.

NEXT: HOW'S PROPORTIONS?

SET V. SIZE & H. SIZE, LIGHT ALL SECTIONS, AND ADJUST. SOME MAY NEED INDIVIDUAL ATTENTION. ROUGH IT IN FOR NOW.

THIS IS ANOTHER GOOD POINT TO 'KEEP IT'

NEXT, I SET ROTATION POINTS —
(THESE ARE NOT ONLY THE AXIS THE SECTIONS ROTATE AROUND, THEY CONTROL WHERE THESE SECTIONS WILL CHANGE SIZE FROM.)

FIRST: DO YOU HAVE A BUNCH OF SECTIONS THAT SHOULD ROTATE TOGETHER, LIKE THE FEATURES ON A HEAD?

YES? LIGHT 'EM UP, AND USE INDV. V. POS AND INDIV. H. POS TO MOVE THE WHOLE STACK TO THE COMPLETE LIMIT OF TRAVEL LEFT AND UP (OR RIGHT AND DOWN, YOUR CHOICE — JUST SHOVE EVERYTHING UP AGAINST THE SAME WALL -- HARD!)

THEN BRING 'EM BACK ONSCREEN AND YOU WILL FIND THAT ALL THE ROTATION POINTS HAVE BEEN NEATLY STACKED ONE ATOP ANOTHER, AND ONE TWIST OF THE ROTATION KNOB WILL TURN ALL OF THEM TOGETHER.

NOW, TO GET HIS NOSE OUT OF HIS RIGHT EAR....

SET 'H. AXIS', 'V. AXIS', 'ROTATION'
(AND 'DISPLAY ROTATION POINTS' IF YOU LIKE, BUT WATCH IT — THOSE POINTS ARE NOT ACCURATE) (DON'T FORGOT TO TURN 'EM OFF BEFORE ON TAPE)
TAKE EACH SECTION ONE AT A TIME AND MOVE IT AND ROTATE IT (THE ROTATION POINT STANDS STILL) UNTIL EACH PART MOVES AROUND ITS AXIS THE WAY YOU WANT IT TO.
SHUT OFF 'DISPLAY ROTATION POINTS')

USE 'INDIV H. POS' AND 'INDIV V. POS' AND 'ROTATION' TO BUILD YOUR FIGURE —
-- ALWAYS MOVE THE 'STACKED' SECTIONS AS A GROUP. WITH THESE CONTROLS. — USE 'AXIS' TO MOVE THEM INDIVIDUALLY.

LOOKS OK?

HIT 'KEEP IT' AGAIN.
(EVERY TIME YOU PUT IT ON TAPE, YOU'RE MAKING SURE THAT A GOOF OF YOURS WON'T IRRETRIEVABLY LOSE ALL THAT YOU'VE DONE SO FAR. 'RECALL FRAME 1' WILL BRING IT RIGHT BACK AGAIN.)

(YOU SEE, UNTIL IT'S ON TAPE, IT'S VERY, VERY FRAGILE....)

NOTE: SHOULD YOU HIT 'DELETE' INADVERTENTLY, AND WANT TO RESCUE THE ONE FRAME ~~[illegible]~~ ON SCREEN, HIT 'CH SC' (CHANGE SCENE) ENTER THE NUMBER OF AN UNUSED SCENE, AND WHEN CAESAR ASKS "USE THIS FRAME" — TELL HIM YES. THEN HIT 'KEEP IT.' YOU MAY NOW WORK IN THE NEW SCENE, OR USE 'INSERT' TO PUT THE FRAME BACK IN THE OLD SCENE.

BRACE UP — ONLY ONE MORE PREPARATORY STEP TO GO.
AND IT'S A FUN ONE:

OSCILLATORS

THESE ARE YOUR 'SECTION BENDERS'.
SELECT A SECTION THAT NEEDS BENDING
SET 'AO AMP' 'OFF' 'AO FREQ'
AND LIGHT AN OSCILLATOR -- SAY THE 'VERT' OSCILLATOR.
WHICH WILL AUTOMATICALLY GIVE YOU A SINE WAVE
AT A 'HALF VALUE' FREQUENCY.

WHAT HAPPENS?
WELL, 'AO AMP' (OSCILLATOR AMPLITUDE)
CONTROLS HOW BIG A BEND YOU GET
FROM ONE END ———
THROUGH THE MIDDLE — ———
TO THE OTHER ———

'AO FREQ' (OSCILLATOR FREQUENCY)
CONTROLS HOW MANY BENDS YOU GET.
FROM ZERO —— ———
TO MAXIMUM
— THE VERTICAL OSCILLATOR WILL GIVE YOU ABOUT
THREE COMPLETE CYCLES BEFORE IT PEAKS OUT.
THE HORIZONTAL AND DEPTH OSCILLATORS WILL GIVE YOU
MORE CYCLES THAN I CAN COUNT.

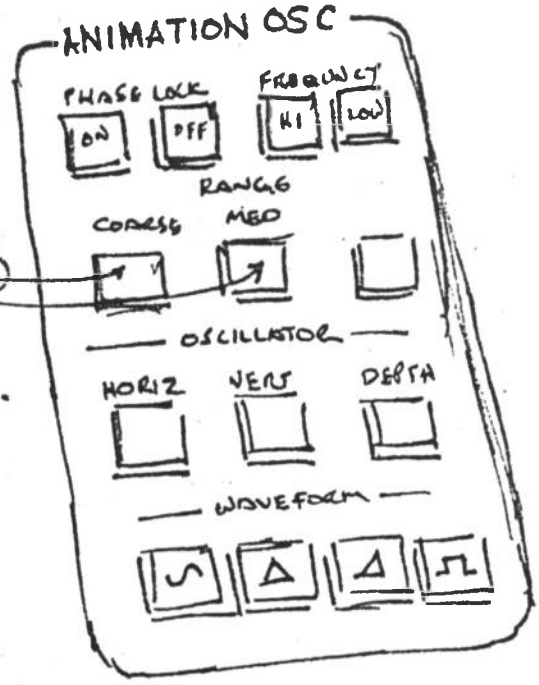
THE FOUR WAVEFORM BUTTONS PICK THE SHAPE OF
THE DISTORTION

SINE:
TRIANGLE
RAMP
AND SQUARE

AND THESE TWO BUTTONS SELECT THE POINT AT WHICH THE OSCILLATION STARTS (PHASE)

...THAT IS, WHERE ON THE ARM, YOU WANT TO PUT THAT ELBOW.

THIS SWITCH PUTS THOSE BUTTONS INTO HIGH OR LOW GEAR.



IF YOU HOLD ONE BUTTON DOWN THE WAVE WILL MOVE ACROSS THE ART, AND YOU GET A FLUTTERING FLAG EFFECT.

YES, YOU CAN ANIMATE WITH THOSE, BUT THERE'S A JOKER IN THE DECK:

JUST ABOVE THE KEYBOARD IS A NUMBER READOUT. WHEN YOU PUSH THE BUTTON, IT GOES FROM BLANK (ZERO) UP THROUGH 9999---OR DOWN FROM 9999, DEPENDING ON WHICH ONE YOU PUSHED-- THROUGH ZERO AGAIN. THIS IS CAESAR'S NUMBER MAP OF THAT OSCILLATOR'S PHASE.

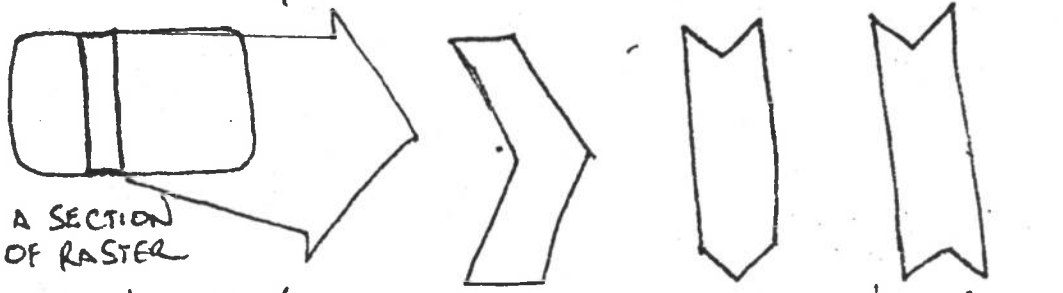
IF YOUR KEY FRAMES RUN 3000 - 7000 - 1000 - 5000 - 9000

CAESAR ALWAYS ANIMATES OVER THE SHORTEST DISTANCE TO HIM-. SO AT THIS POINT THE 'FLUTTER' WILL TURN AROUND AND RUN BACKWARD. IT'S FIXABLE, BUT A NUISANCE.

ANOTHER NUISANCE: CAESAR IS GRUMPY ABOUT CHANGING WAVEFORMS UNLESS THAT PHASE NUMBER IS ZERO.

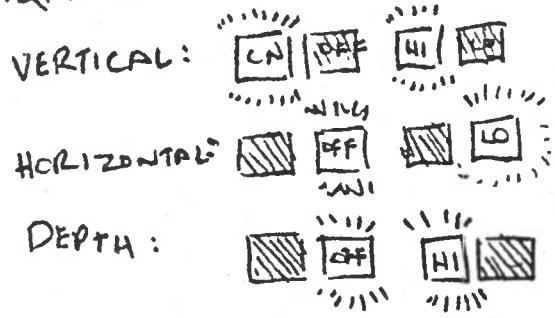
HOW THEY WORK ON THE SECTIONS:

THE TERMS 'HORIZONTAL' AND 'VERTICAL' DON'T HAVE A DAMN THING TO DO WITH ANYTHING EXCEPT HOW THE ARTWORK IS SCANNED BY THE INPUT CAMERA



I ALWAYS THINK OF THE 'VERTICAL' OSCILLATOR AS "LONG WAY" AND THE 'HORIZONTAL' AS "SHORT WAY"

NOTE THAT TO GET THESE SHAPES, THE PHASE LOCK & FREQUENCY LIGHTS WILL LOOK LIKE THIS:

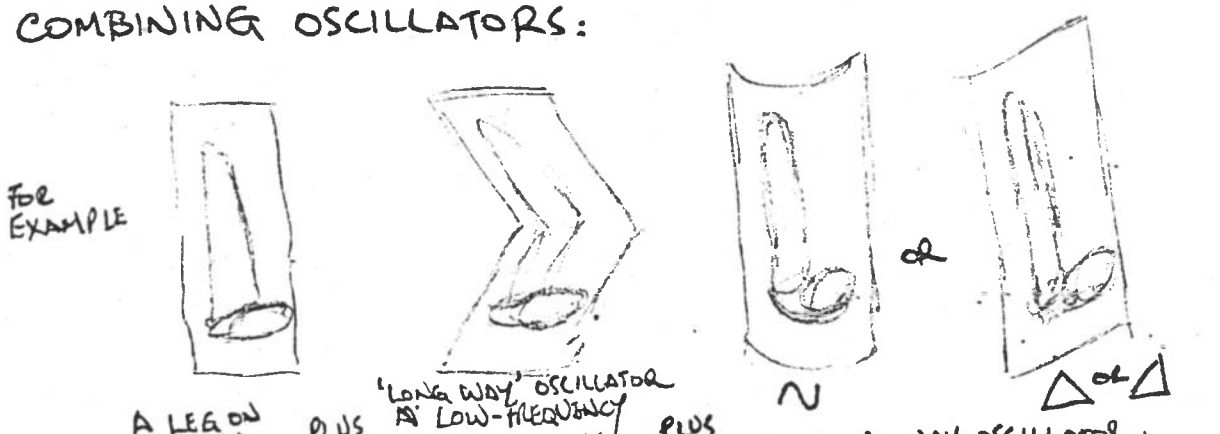


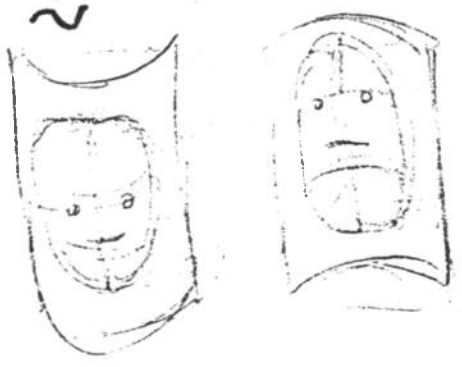
TRY SCREWING THESE UP FOR SOME INTERESTING SPAGHETTI PATTERNS...

ALL THREE OF THESE CAN BE APPLIED TO ANY, SOME, OR ALL SECTIONS....

BUT YOU MAY HAVE TO TURN OFF THE SECTION LIGHT (ANIMATE MUST BE ON) TO CHANGE OSCILLATORS, THEN TURN ON THE SECTION LIGHT AGAIN... SOMETIMES CAESAR'S GRUMPY ABOUT THAT, TOO...

COMBINING OSCILLATORS:



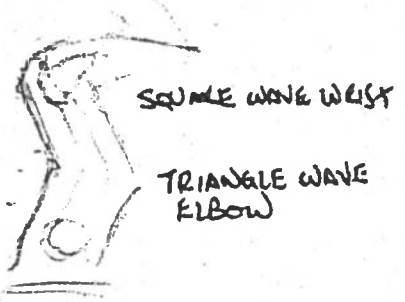


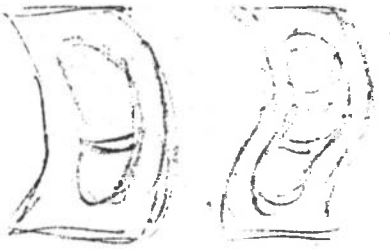
WITHIN LIMITS, THE CHARACTER CAN NOD HIS HEAD

....EXPERIMENT WITH THE COMBINATIONS.

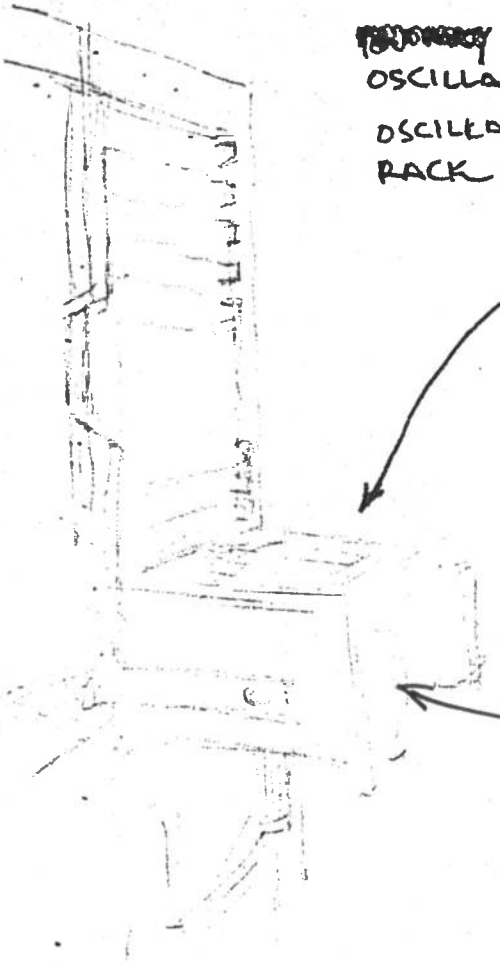
BOTH THE VERTICAL AND HORIZONTAL OSCILLATORS CAN BE APPLIED "THE LONG WAY"

--VERY USEFUL





TWO SINE WAVES ON A BODY SECTION FOR A 'C' CURVE AND AN 'S' CURVE



TO CHANGE THE HORIZONTAL (SHORT WAY) OSCILLATOR TO A SECOND VERTICAL (LONG WAY) OSCILLATOR, GO TO THE RIGHT-HAND PANEL RACK AND LOOK IN THE DRAWER.

△ 1 — KNOBS IN SHUT-
THE SWITCHES ARE NOW ON
THE FRONT OF THE DRAWER

NOW - THE ACTUAL ANIMATION IS DEAD SIMPLE:

YOU HAVE FRAME ONE

HIT 'COPY' AND ENTER THE NUMBER OF YOUR NEXT KEY FRAME.
[IF YOU DON'T KNOW THE NUMBER -- GUESS. THIS THING RUNS AT 30 FRAMES PER SECOND, SO PICK A LIKELY NUMBER AND TRY IT. YOU CAN ALWAYS CHANGE IT LATER IF YOU DON'T LIKE IT.]

REARRANGE THE PARTS UNTIL THIS FRAME LOOKS THE WAY YOU WANT IT.
[YOU'LL USE IND. H, IND. V, ROT FOR MOST MOVEMENT
H. AXIS, V. AXIS, ROT FOR MOVING ONE SECTION ONLY OF A 'STACK' (THOSE WITH STACKED ROTATION POINTS)
AO [redacted] AMP FOR OSCILLATOR CHANGES,
H. SIZE & V. SIZE FOR SQUASH-AND-STRETCH AND ADJUSTMENTS TO THE OSCILLATOR CHANGES.

GENERALLY, AVOID USING CHAR H., CHAR V., DEPTH AT THIS STAGE. YOU'LL WASTE THEM NOW, AND NEED THEM LATER.

NOTE THE FRAMES THAT YOU THINK WILL NEED INTENSITY CORRECTIONS AND SAVE THEM FOR LATER. INTENSITY DRIFTS TOO RAPIDLY TO MAKE CORRECTING-AS-YOU-GO WORTHWHILE.]

YOU CAN CONTINUE COPYING UNTIL YOU HAVE EIGHT KEY FRAMES SHOWING IN THE BUFFER. THERE IS A SLOT FOR A NINTH KEY FRAME — DON'T USE IT! THERE IS A PROGRAM ERROR IN IT THAT WILL PUT BAD DATA IN EVERY FRAME OF ANIMATION AFTER YOUR EIGHTH KEY FRAME -- DATA THAT IS NEARLY IMPOSSIBLE TO DETECT OR ERADICATE EXCEPT BY DELETING EVERY AFFECTED FRAME -- AND IT IS DATA THAT WILL SCREW UP EVERY ANIMATE USING AN AFFECTED FRAME.

ALL YOUR FRAMES POSITIONED TO SUIT YOU?

DO YOU WANT ANY ACCELLERATIONS OR DECELERATIONS?

LOOK AT THE FIRST FRAME OF THAT ACCELLERATION

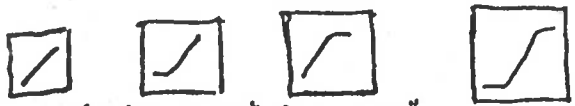
[EACH NUMBER KEY ON THE KEYBOARD, WHEN PUSHED, CAUSES YOU TO LOOK AT THE 'KEY FRAME' OCCUPYING THAT NUMBERED SLOT. PUNCHING THE 'GO' BUTTON IN PLAYBACK WILL ADVANCE YOU ONE 'KEY FRAME' PER PUNCH.]

ABOUT THAT STACK OF MOUTH POSITIONS:

COPY FRAME 1 TO 2.
LIGHT 'ANIMATE' SECTION __(WHICHEVER THE MOUTHS ARE ON)'
SET 'H.AXIS, V. AXIS, S.B. START (YOU MAY NEED S.B. WIDTH NOW AND AGAIN)
AND USING S.B. START, BRING UP THE SECOND MOUTH.
USE AXIS CONTROLS -- AND ROTATION, IF NEEDED TO POSITION IT
AND THE BLANKING CONTROLS TO TRIM IT.
REPEAT THE STEPS UNTIL YOU HAVE EACH MOUTH (OR WHATEVER)
ON ITS OWN FRAME, PROPERLY POSITIONED.
HIT KEEP IT. - YOU NOW HAVE YOUR 'LIBRARY'
RECALL FRAME 1
CHANGE SCENES - TO AN EMPTY SCENE.
WHEN CAESAR ASKS 'USE THIS FRAME' TELL HIM 'YES.'
YOU'LL DO ALL YOUR ANIMATION HERE, THEN BRING IN
THE MOUTHS LATER FROM THE 'LIBRARY'.

IF YOU MUST CORRECT INTENSITY NOW,
MAKE A LIST OF YOUR KEY FRAMES →
TO MAKE IT EASIER TO FIND THEM LATER.

WE HAVE FOUR DIFFERENT 'ACCELERATIONS' or "FAIRINGS":



LINEAR "SLOW-OUT" "SLOW-IN" SLOW IN & OUT (DOUBLE-ENDED)

LINEAR: EQUAL SPACING. CAESAR WILL GIVE YOU THIS NORMALLY IF YOU DON'T SPECIFY ANYTHING ELSE. GOOD FOR CORRECTING A BAD GUESS.

SLOW-OUT: ACCELERATING MOVEMENT

SLOW-IN: DECELERATING MOVEMENT

DOUBLE-ENDER: ACCELLERATES TO START, DECELERATES TO STOP. ALWAYS SYMMETRICAL.

SELECT ONE, PUNCH ITS BUTTON, AND CAESAR WILL ASK YOU THE NUMBER OF FRAMES TO 'FAIR'. TELL HIM (KEYBOARD). IF YOU WANT 'ALL'—GIVE HIM A VERY LARGE NUMBER.

ALL 'FAIRINGS' SELECTED?

PUNCH "KEEP IT".

CAESAR NOW TAKES ANY INFORMATION HE HAS ON THE MAGNETIC TAPE, COPIES IT TO THE OTHER, ADDING ANY NEW INFORMATION OR CHANGES THAT YOU PUT INTO THE BUFFER, THEN CLEARS THE BUFFER MEMORY.

[NOTE: IF HE SAYS "NO LINK WITH MAG TAPE" IT MEANS YOU DON'T HAVE EITHER FRAME ONE OR A FRAME FROM TAPE IN THE BUFFER. AND HE DOESN'T KNOW HOW TO BRIDGE THE GAP YET. RECALL A FRAME, OR COPY A FRAME TO ONE. AND TRY AGAIN.]

WATCH CAESAR DO THE DIRTY WORK, THEN RESUME ANIMATING.

To PLAY BACK:

HIT "ABORT" ('MEANS 'RETURN TO MASTER CONTROL', 'STATUS REPORT', AWAIT INSTRUCTIONS.')

HIT 'PLAYBACK' AND ANSWER CAESAR'S QUESTIONS.

(IT'S BEST TO START WITH SENSE SWITCH 4 ON THE 316 IN THE 'OFF' POSITION. PUSHING IT DOWN GIVES YOU THE DELAY MODE -- BUT IF YOU START IN IT, ANOTHER PROGRAM ERROR TEMPORARILY SCREWS UP YOUR BACKGROUND COLOR.)

PUSH 'GO'. THERE IT IS.

YOU ALSO HAVE A 'STOP' AND A 'SLOW MOTION' (15:1)

AND CAESAR WILL ASK YOU AFTER EVERY PLAYBACK: "ONE MORE TIME?"

'YES' RESETS HIM.

'NO' RETURNS YOU TO MASTER CONTROL. 'ABORT' TELLS CAESAR THAT THE PLAYBACK'S OVER.

1364
- 1309
55

NOTE — YOU CAN MAKE BOTH TAPES ALIKE BY CALLING BACK ONE FRAME (IN ANIMATE) MAKING NO CHANGES, AND SAYING 'KEEP IT'. YOU CAN NOW SAVE ONE TAPE, PUT UP A BLANK ONE, AND COPY FROM THE REMAINING GOOD TAPE ONTO IT [SEE 'TO COPY ONE TAPE ONTO ANOTHER.']

TO CHANGE ANIMATION ALREADY ON MAG TAPE.

GO INTO ANIMATE AND RECALL THE FRAMES YOU WISH TO CHANGE.
[NOTE: IF YOU RECALL A FRAME TWICE, CAESAR WILL ASK YOU: "I NEED A FRAME NUMBER!" THIS MEANS HE WILL COPY THAT FRAME WHEREVER YOU TELL HIM TO... AND 'COPY' ALWAYS MEANS 'ANIMATE EVERYTHING FROM THE KEY FRAME BEFORE THIS ONE TO THE KEY FRAME AFTER IT.
-- THE SAME AS THE 'FAIR ALL PARAMETERS (FAP) KEY.
IF YOU'RE CHANGING A FEW THINGS ONLY, THIS MAY BE A BUMMER.
TELL HIM "9999", THEN DELETE "FRAME 9999". PROBLEM SOLVED.

REARRANGE PARTS, COPY FRAMES TO NEW NUMBERS TO CHANGE TIMINGS--WHATEVER.

[NOTE: IF YOU CHANGE AN OSCILLATOR — LEAVE IT & THE SECTION LIGHT ON, LOOK AT EVERY KEY FRAME WITH SELECTOR ON AO AMP [AND NO FREQ IF YOU'RE CHANGING THAT) AND NO OTHERS, AND LIGHT THE 'ANIMATE' LIGHT FOR EACH.... OTHERWISE CAESAR MAY ANIMATE ONLY THE ONE FRAME'S OSCILLATOR CHANGE IN A ONE-FRAME "POP".]

CHANGE ACCELLERATIONS, OR REENTER FOR THE SAME ONES FOR THE CHANGED SECTIONS,
AND HIT "KEEP IT".

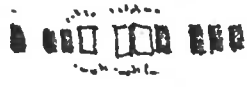
REMOVING A ROTTEN ANIMATE.

ABORT. DID YOU ADD OR SUBTRACT ANY FRAMES WITH THIS ANIMATE?

NO: CHANGE TAPE CONTROLS SO THAT 'UNIT 1' IS NOW 'UNIT 2' AND VICE VERSA.
GO ON ABOUT YOUR BUSINESS.

YES: LOOK AT THE STATUS REPORT
ARE YOU ON MAG TAPE 1 OR MAG TAPE 2?
MAG TAPE 1 - CHANGE TAPE CONTROLS SO THAT 'UNIT 1' IS NOW 'UNIT 2' AND VICE VERSA.
MAG TAPE 2 - NO PROBLEM.

GIVE CAESAR '16 001' (SEARCH TAPE 1 AND GIVE ME A STATUS REPORT)



YOU'VE JUST 'GONE BACK' ONE ANIMATE. [redacted] THAT'S YOUR LIMIT. TWO ANIMATES BACK IS ANCIENT HISTORY, SINCE EVERY TIME YOU HIT 'KEEP IT' CAESAR WRITES FROM ONE TAPE TO THE OTHER, ADDING WHATEVER CHANGES YOU HAD IN THE 'BUFFER' MEMORY. ONCE A TAPE IS WRITTEN ON, THE 'OLD' INFORMATION IT CONTAINED IS GONE FOREVER. ANY TAPE MAY BE PLAYED BACK AS OFTEN AS YOU LIKE WITHOUT AFFECTING ANYTHING.

AN EFFICIENT SEQUENCE OF OPERATIONS
FOR A NEW SCENE

EITHER "16000" OR "CH 8C" & NUMBER OF AN EMPTY SCENE (THERE ARE 6 TOTAL)

CAESAR ASKS "USE THIS FRAME?"
YOU REPLY "NO" (ON KEYBOARD) - CAESAR TRIES TO SECTION ANIMATION.
IF IT DOESN'T WORK "ENTER NUMBER OF SECTIONS" — GO TO CAESAR BOOK.

1) INTENSITY (ANY KNOB) - JUST ENOUGH TO SEE WHAT YOU'VE GOT.

2) CHR H. POS CHR V. POS DEPTH
RUN EVERYTHING BACK TO A DOT -- YOUR VANISHING POINT --
POSITION IT TO SUIT YOU. THEN BRING IT BACK UP BIG ENOUGH TO USE.

3) a) ONE ROTATION POINT FOR ALL SECTIONS. (IF EACH IS TO HAVE ITS OWN, GO TO 3)
INDIV H. POS IND. V POS. ROTATION
MOVE EVERYTHING AS FAR LEFT AND UP AS IT WILL GO.
BRING IT ALL BACK. IT IS NOW STACKED IN A HEAP.
GO TO NEXT STEP.

3) b) H. AXIS V. AXIS ROTATION
MOVE SECTIONS ONE-AT-A-TIME WITH ROTATION. ROTATION POINT WILL STAY PUT. USE H AXIS & V AXIS TO MOVE SECTION ONTO ROTATION POINT, AND USE ROTATION TO SEE WHERE IT IS.

4) H. AXIS V. SIZE H. SIZE
USE V. SIZE AND H. SIZE TO BRING PARTS INTO ROUGH PROPORTION WITH ONE ANOTHER.

5) INDIV. H. POS INDIV. V. POS ROTATION
MOVE SECTIONS & ASSEMBLE FIGURE.
(USE V & H SIZE AS NECESSARY TO TOUCH UP)

6) AO AMP INDIV V. POS. AO FREQ
SET OSCILLATORS AS DESIRED. (SEE RECIPES)
TOUCH UP WITH INTENSITY

7) INDIV. H. POS. INDIV. V. POS. ROTATION
ANIMATE.

V SIZE – "STRETCHES" THE SECTION ACROSS THE DIRECTION OF SCAN.

H SIZE – "STRETCHES" THE SECTION WITH THE DIRECTION OF SCAN

NOTE - SIZE MOVES ARE CENTERED ON THE ROTATION POINT. --IN THEORY. THESE ALSO ARE PROPORTIONATE TO THE DEPTH SETTING.

DEPTH – CHANGES HORIZONTAL AND VERTICAL SIZE RELATIVE TO THE VANISHING POINT. EVERYTHING EXCEPT CHR H POS AND CHR V. POS IS PROPORTIONED TO THIS, SO YOU CAN MOVE A FIGURE IN DEPTH WITHOUT LOSING PREVIOUS ANIMATION.

SB START – (SECTION BLANKING START)(NORMAL SETTING) CREATES A MOVING MATTE WINDOW THAT HIDES THE VIDEO ON THE RASTER. STARTS FROM THE TOP OF SECTION. WORKS ONLY IN THE DIRECTION OF SCAN.

SB START (SP BLK SETTING) HOLDS THE MATTE WINDOW STEADY AND MOVES THE VIDEO IMAGE 'BEHIND' IT.

SB WIDTH – (BOTH SETTINGS) DETERMINES WIDTH OF BLANKING WINDOW. MOVES FROM BOTTOM OF RASTER TO TOP. STARTS FROM TOP OF BLANKING WINDOW, IF PRESENT, OR FROM BOTTOM OF ART, IF NOT.

INTENSITY – VARIES VOLTAGE LEVEL OF VIDEO IMAGE. USUALLY USED TO KEEP VIDEO LEVELS -- HENCE COLORS -- CONSTANT DURING DEPTH AND/OR SIZE CHANGES.

AO FREQ – ANIMATION OSCILLATOR FREQUENCY – CONTROLS "HOW MANY" BENDS EACH OSCILLATOR PUTS ON THE SECTION.

WHAT DO THE FUNCTION SWITCHES DO TO THE ANIMATING SECTION?

SECT LGTH – FOR MANUALLY SETTING WHERE THE SECTION LINES FALL ON THE KODALITH.

CHR H POS – MOVES VANISHING POINT HORIZONTALLY.

CHR V POS – MOVES VANISHING POINT VERTICALLY.

NOTE THAT EVERYTHING IS ANCHORED TO THE VANISHING POINT. WHEN YOU MOVE IT, YOU MOVE <u>EVERYTHING</u>.

NOTE ALSO THAT [redacted] THE VANISHING POINT AND ITS MOVEMENTS ARE NOT AFFECTED BY ANY OTHER CONTROLS -- THEY ARE CONSTANT.

AO AMP – OSCILLATOR AMPLITUDE – MAKES THE 'BENDS' LARGER OR SMALLER.

H AXIS – MOVES THE SECTION'S RASTER ACROSS THE DIRECTION OF SCAN (THE SHORT WAY) WHILE LEAVING THE ROTATION POINT IN PLACE.

V AXIS – MOVES THE RASTER WITH THE SCAN DIRECTION, LEAVING ROTATION POINT IN PLACE.

INDIV H. POS. – MOVES THE ROTATION POINT (AND, OF COURSE, THE RASTER ASSOCIATED WITH IT) IN RELATION TO THE VANISHING POINT – HORIZONTALLY.

INDIV V. POS – MOVES THE ROTATION POINT VERTICALLY IN RELATION TO THE VANISHING POINT.

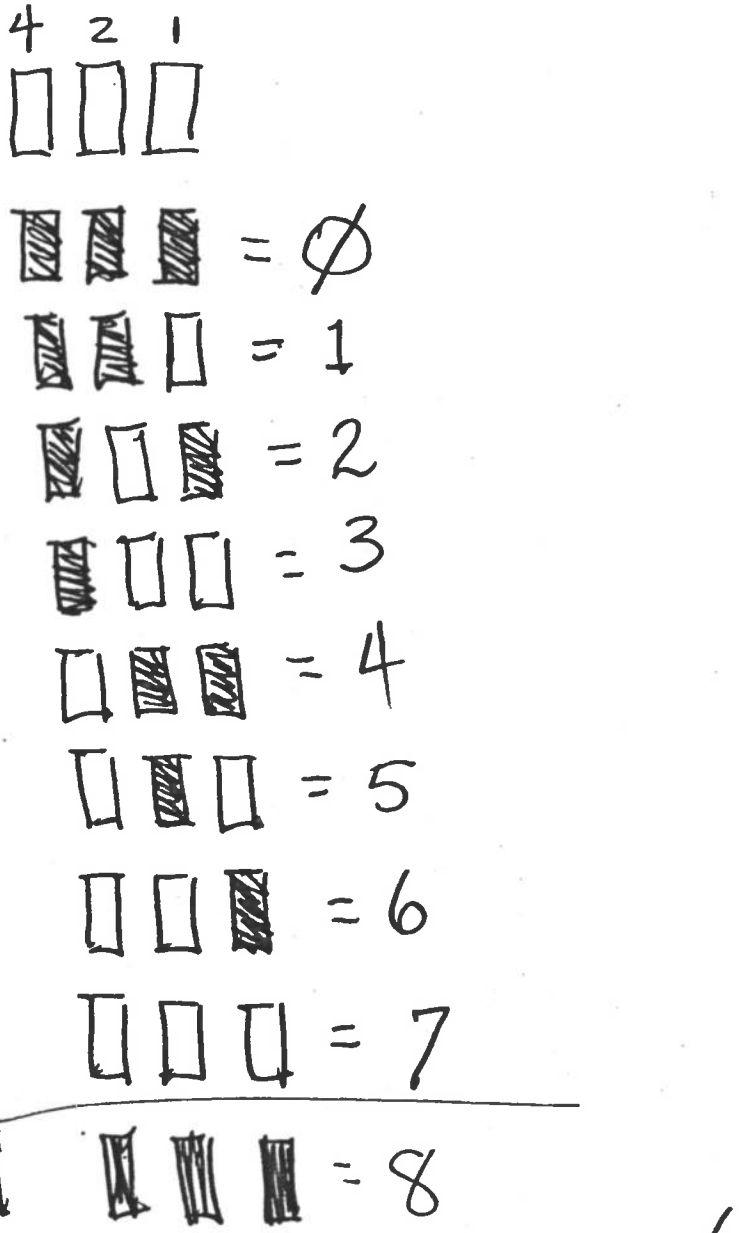
NOTE – THESE MOVEMENTS ARE PROPORTIONAL TO THE DEPTH SETTING. THEY ARE <u>NOT</u> CONSTANT.

OFF – JUST WHAT IT SAYS. <u>NO</u> FUNCTION.

ROTATION – ROTATES THE SECTION PARALLEL TO THE SURFACE OF THE SCREEN AROUND ITS ROTATION POINT.

OCTAL ARITHMETIC

- BASE 8 -

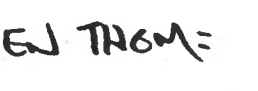


OCTAL 10

GUIDELINES FOR MAKING CELS

1) CENTER ART ON CELS (USE FIELD GUIDE)
   CAN BE ½" OR SO OFF EITHER WAY WITHOUT CAUSING ANY PROBLEMS — MORE HUNTS

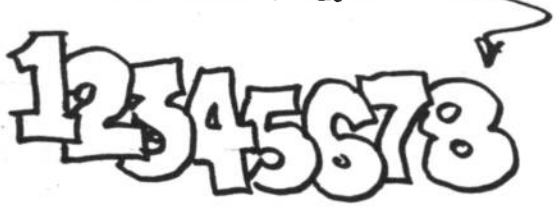
2) TRY TO KEEP ART INSIDE A 10 FIELD (USE FIELD GUIDE)

3) NEVER FIT SECTIONS TOGETHER LIKE SO - IT SAVES SPACE, BUT CAESAR NEEDS ROOM TO DRAW A LINE BETWEEN THEM:  SPACE SHOULD BE ABOUT ⅛" OR BETTER.

4) MANY SEPARATE PIECES — IF THESE ARE TO BE TREATED AS ONE SECTION, PUT A CLEAR LINE AS WIDE AS THE ART UNDER THE SECTION → . CAESAR WILL THEN AUTOMATICALLY TREAT IT AS ONE SECTION.

5) ALL CELS 'TOP-PEGGED'

6) CAESAR READS SECTIONS FROM LEFT-TO-RIGHT. 'NEAREST' PART IS ON THE LEFT (SECTION ONE) TO THE FARTHEST ON THE RIGHT



GRAYSCALING:

WE USE FIVE "SHADES OF GRAY" ON OUR CELS, RANGING FROM CLEAR (WHITE -- NO GRAY) TO [redacted] OPAQUE (BLACK -- SOLID)

THE MACHINES CAN RECOGNIZE THOSE GRAYS (IF THEY'RE NOT TOO DIRTY AND PATCHED) AND LETS US ASSIGN COLORS TO EACH GRAY LEVEL AS WE CHOOSE.

CLEAR - OUR LIGHTEST AND BRIGHTEST COLOR (NOTE: IN TV, RED IS 'BRIGHTER' THAN WHITE)

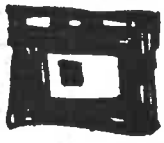
LIGHT - OUR NEXT DARKEST COLOR

MEDIUM - OUR NEXT DARKEST COLOR

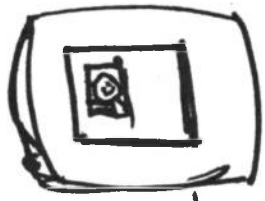
DARK - OUR DARKEST COLOR (USUALLY USED FOR OUTLINES & BLACK -- AND PHOTOGRAPHED DIRECTLY ONTO THE KODALITH

OPAQUE - IS THE BACKGROUND
BOTH MACHINES READ IT AS "INVISIBLE"
AND LET THE BACKGROUND SHOW THROUGH.

IT'S THE TAPED AREAS AND SOLID BLACK AREAS ON THE KODALITH AROUND THE CLEAR-AND-GRAY ART. SOMETIMES WE'LL USE AN OPAQUE AREA INSIDE ON SECTION...



KODALITH



ANIMATION

... TO USE AS A WINDOW

STARTING CAESAR

SECTION
"ESTAB VARIABLE POINT

RECALL
#40
STORE
COPY
#50
STORE
COPY
#60
KEEP IT
RECALL (LAST FRMT)
COPY

140
150
160

~~ABORT~~

;

;

~~STORE WAIT~~

PLAYBACK

YES

60

(YES, SLOW M, 60)

NO

ANIMATE

RECALL

LAST FR

STORE

COPY onto FR

#

STORE

ANIMATE

KEEP IT OR → ABORT

230

RECALL #
STORE
ANIMATE

COPY
#
STORE
ANIMATE
KEEP IT

OFF —

DISPLAY ARTWORK
TAPES= ON LINE
REWIND (TWICE EACH)

COMPUTER S1
MASTR CLEAR

MONITORS OFF
COLOR BARS UP
PROC: ANALOG, TEST, ART
UN PLUG CABLES

TO GET OUT OF ANY BIND:

~~MASTER~~ 1+216 COMPUTER:

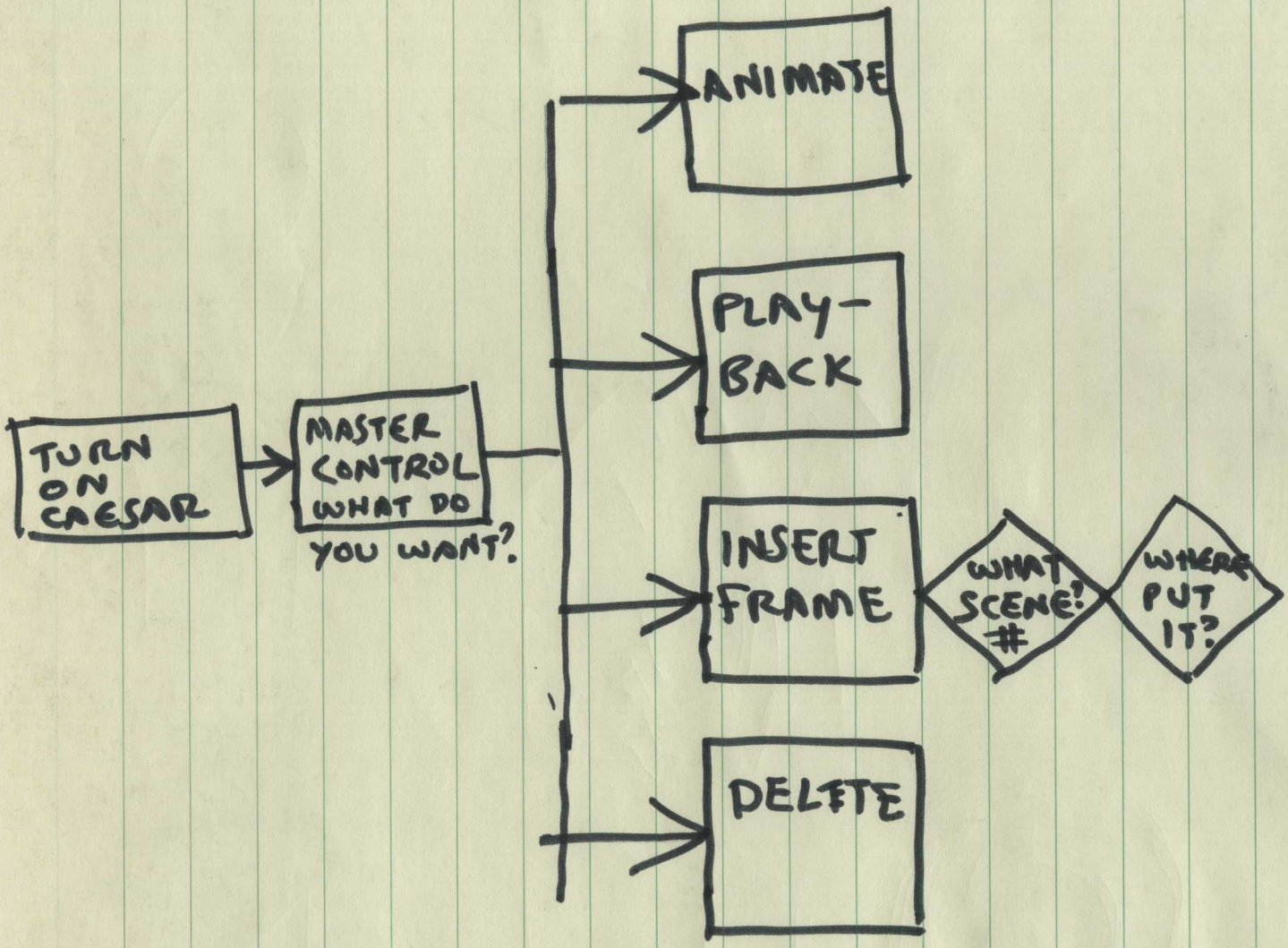
SINGLE INSTRUCT

MASTER CLEAR

16001

RUN

START



NATIONAL
45-100 EYE-EASE
45-400 20/20 BUFF
45-495 WHITE
Made in U.S.A.

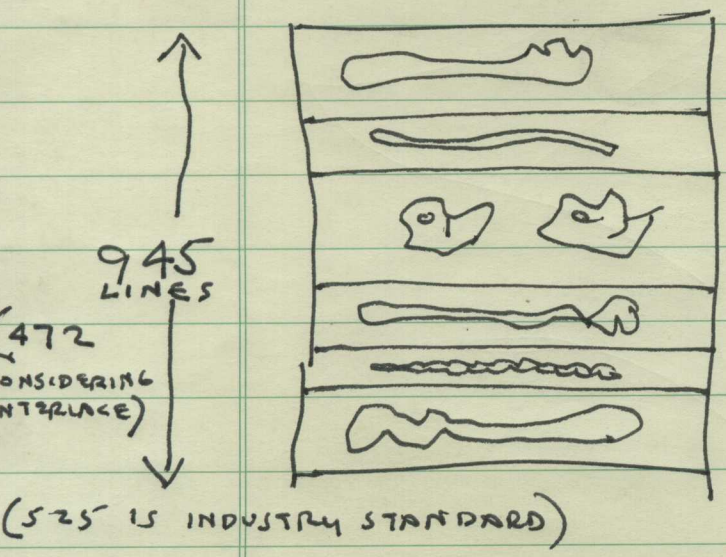
NATIONAL
45-100 EYE-EASE
45-400 20/20 BUFF
45-495 WHITE
Made in U.S.A.

ASSNMT
DESIGN A CHARACTER
AND ITS SECTIONS WITH SB
INVENT DIF KINDS
ANIMAL? THING? ROBOT?

JUNE 29 '78
EDS' BLACKB'D TALK

CAESAR IS DIGATAL ~~FED~~ CONTROLED SCANIMATE

KOMALITHS LIKE RUBBER SHEETS



(525 IS INDUSTRY STANDARD)

SCANIMATE HAS 5 SECTIONS
CAESAR HAS 8 SECTIONS

TWO WAYS OF DOING OVERLAP

OVERLAP - FRONT TO BACK (POOR QUALITY)
MULTIPLE PASS KEYING - BACK TO FRONT

MICRO SECOND = MILLIONTH
MILI SECOND = THOUSANDTH

OSCILATORS = HORIZ, VERT AND DEPTH

CAESAR II MAY HAVE MULTIPLE SCAN CONVERTERS

"POP" = CHANGE W/O GRADUAL CHANGE TO DIFF ARTWORK

SEVEN BASIC LIP SHAPES FOR LIP SYNC

THE OUTPUT OF CAESAR CAN → INTO SCANIMATE BUT N VICE-VERSA

TO BEND A LEG YOU USE THE OSCILATOR FUNCTION

"MICRO PROCESSOR CONTROL OF FRAME STORE WILL PUT US ALL OUT OF BUSINESS." PHILL ZIMMERMAN JULY '78

Control console for Computer Image Corporation's automated animation system. According to Lee Harrison III, president of the company and developer of the system, "Great pains were taken to make the system operation invisible to the user -- to give him the feeling he's merely wielding an electronic paintbrush."

"Electronic Paintbrush" Adds New Dimension To The Graphic Arts

The group of young Indians crowding around the TV screen whoop in anticipation as the smart-alecky coyote, ignoring the admonition of the wise old lizard, slides down the sand dune riding atop a large, flat rock—only to lose his balance and get overtaken and flattened in the process. "That's perfect," says the Navaho elder with a smile, "tape it." The console operator pushes a button and the luckless coyote again slides down the slope—this time so that his every action can be captured on color videotape.

It's the kind of cartoon your kids might see on any Saturday morning TV show, except for two things—the dialogue in this particular sequence is all in Navaho, and the film itself was produced entirely by computer, in an interactive system that permits sequences to be repeated and refined so as to reflect the subtle details of Indian experiences and Indian legend.

Computer animation has made enormous strides during the past two or three years. Combining a hybrid analog-digital computer with television components, systems such as the one at Computer Image Corporation of Denver, Colorado can now produce character animation approaching the quality achieved through conventional animation methods. Perhaps even more significant, such systems can do in one day what a conventional animator working with standard equipment might take as much as two or three weeks to produce. That's why commercial filmmakers are following developments in computer graphics with growing attention.

To produce a basic bit of animation by the old method—for example, the sequence in which the coyote picks up the rock and begins to run with it—would require between 25 and 50 separate drawings, each painstakingly hand-drawn by an artist. With a computer-controlled system, the artist first makes some basic drawings to show the computer what the subject looks like. In the example of the coyote, he would make separate drawings of the rock and the head, body, paws, and tail—a drawing of each of the moving parts of the subject. These few black-and-white drawings on transparent sheets, or "Kodaliths," are the equivalent of dozens, or even hundreds, of conventional "cels"—the individual drawings that form the basis of a manually-created animation sequence. When various parts of the image are to have different colors, the corresponding transparent areas of the Kodalith are masked with variable densities of gray scale so that each area transmits a different amount of light.

The Kodalith is then placed on a light box and scanned by a special TV camera which converts the images into electrical signals and feeds them into the computer. The restructured images next appear on a high-resolution X-Y display where they are again scanned by a TV camera and transmitted to the control CRT on the operator's console.

In Computer Image Corporation's systems, analog techniques allow the operator to manipulate the basic shapes and set up the animation sequence; a Honeywell 316 digital computer with 12K of memory is used for control, storage, and timing of the total animation. This arrangement gives the operator real-time control of the images on the screen—and at least as much flexibility as he would have working with a pencil or paintbrush.

In looking up at the control CRT, for example, our animator would first see his picture of the rock and the jumbled parts of the coyote—he can have as many as eight individually controlled elements on the screen at one time. By manipulating his analog controls, he assembles the coyote and positions the rock where he wants it. He also adjusts the size of the images and the intensity. Next, he moves the image of the coyote to the position on the screen where he wants it to be at the end of the animation sequence. After making similar adjustments for the initial starting position, he sets the length of the sequence from a few tenths of a second to several seconds for that scene. The operator then presses the control that triggers the animation cycle and the coyote moves from the initial to the final position, executing whatever action has been programmed to occur between the two terminal locations. Since the entire sequence has been stored in the computer memory, it can be repeated as often as desired with the simple press of a button. Or selected parts of the sequence may be changed until the entire episode meets the operator's approval.

An "overlap" feature built into the system blanks out portions of a character that are located behind other elements and keeps them from showing through. This permits an arm to pass in front of a character's face, for example, and obscure the face in a realistic fashion without producing what would otherwise appear to be a multiple exposure.

As a rule, color is added to a scene after the animation has been worked out. The colorizer portion of the computer identifies five levels of light intensity and assigns a different color to each level. (This is why elements of the image that are to be the same color must be coded with identical gray tones on the original artwork.) By adjusting the setting of five red-blue-green mixing controls, the operator can paint each area of the image any color he wishes—and even change the colors during a scene. There may be as many as four different colors on a character plus one other color for the background of the scene. The background color is supplied by a color television viewing a separate piece of color artwork. When both animation and color are judged to be optimum, the sequence is recorded on videotape.

But computer-controlled systems do more than simply translate ideas into pictures; they let the artist explore a whole new electronic world of interacting colors and shapes. He can start with a simple image—perhaps a name or company logo—and by varying the waveform, frequency, phase, and amplitude of the shaping function generator, create an endless variety of shapes and colors. The original image explodes, shrinks, grows, undulates, and rearranges its component parts in ways the artist could not possibly have imagined.

As important as these exciting visual effects may be to the individual artist, it's the cost advantage that prompts hard-headed businessmen to buy computer animation systems. An enormous amount of expensive time is saved when an animator can input a minimum amount of initial drawings, set up a few key frames, specify the desired colors, and let a computer "draw" all the intervening frames. If any of the parameters have to be changed, it's merely a matter of adjusting a few controls. And the finished sequence can be viewed immediately—before it's committed to videotape. By contrast, any change in manually executed animations requires the complete redrawing of perhaps hundreds of cels—and there's no assurance that the sequence is satisfactory until the new film or tape can be viewed.

Or, putting it another way, conventional animation is 5% creative and 95% production. With a computer-controlled system that ratio is reversed. As one filmmaker, Hatfield Davis, observes, the goal of computer animation systems is to produce the kind of animation we saw in "Snow White." "But to produce those 83 minutes of "Snow White" took 750 artists working three years to complete 1,000,000 cels.

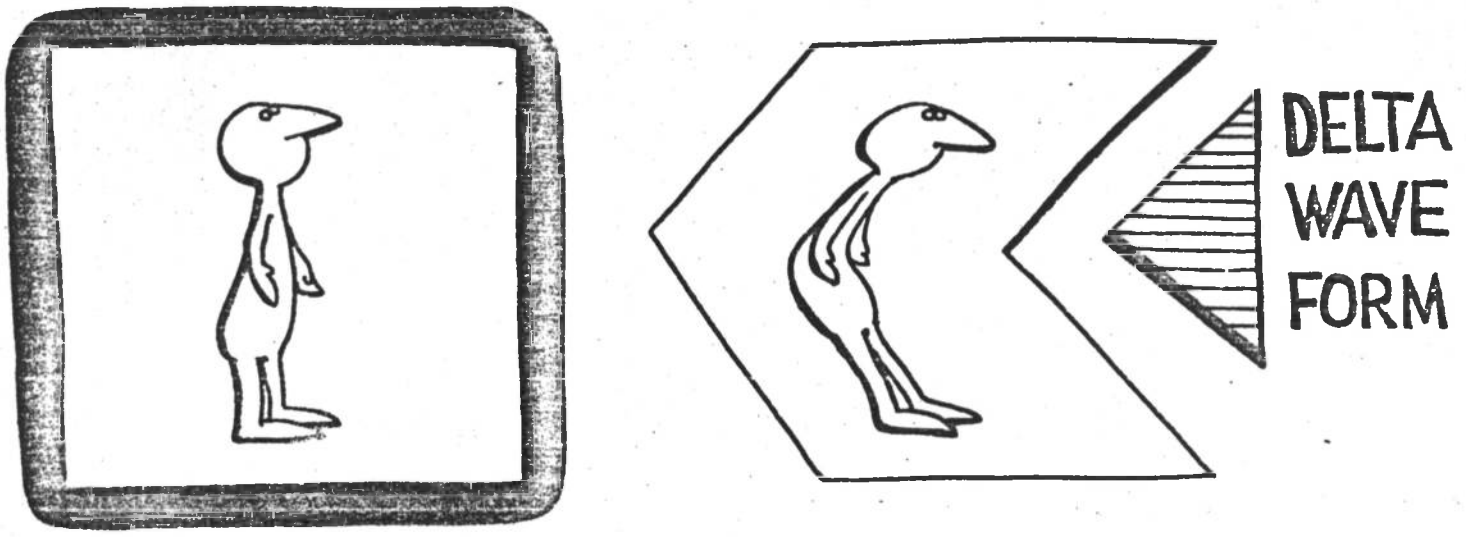
A Better Mousetrap: The CAESAR

by David Holman and L. Bruce Holman

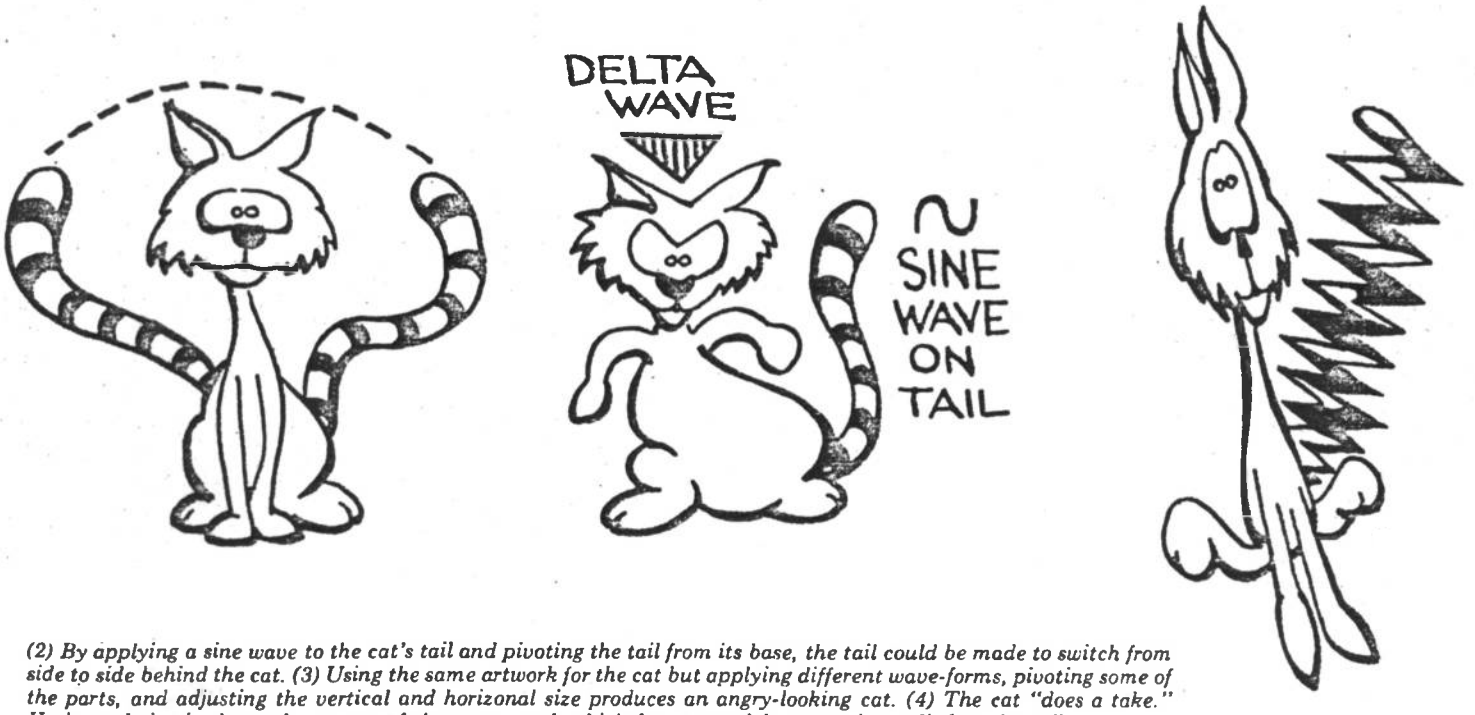
The animator is seated at a control console; before him is a color cathode ray tube on which is displayed a cartoon character frozen in mid-step. The animator adjusts the controls, then depresses a button marked "Animate." A smaller CRT flashes a response: "Doing my thing." And an instant later, the cartoon figure walks across the screen, smiles at the animator, and tips his hat.

Until recently this scene would have been science fiction, but a computer-controlled device now exists which produces fully-articulated cartoon animation. Its function is described as Computer Animated Episodes using Single Axis Rotation—its builders call it CAESAR. CAESAR is far beyond the point of being a mere laboratory curiosity; it is a fully-operational tool producing animated films every day on a time- and cost-efficient basis. The implications of CAESAR for the art of animation are enormous.

CAESAR is a descendant of ANIMAC, the original animating computer designed by Lee Harrison and his associates at Computer Image Corporation. ANIMAC was an extremely resourceful, versatile, and impressive device. It could handle three-dimensional work as well as two. ANIMAC, as a prototype device, suggested other possibilities for com-



(1) A figure displayed within a television raster will follow the shape of the raster when the proper electronic signal is applied.



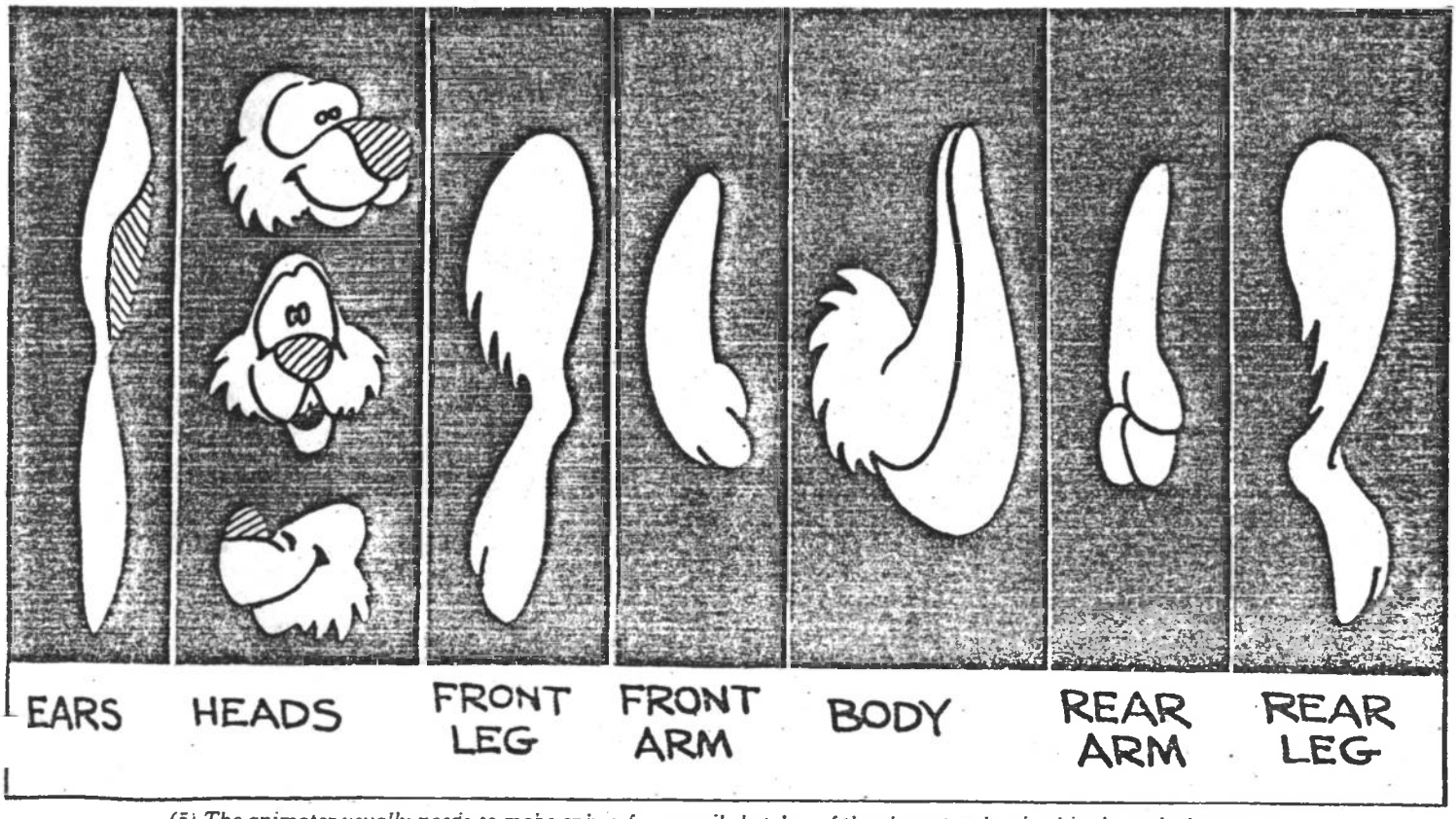
(2) By applying a sine wave to the cat's tail and pivoting the tail from its base, the tail could be made to switch from side to side behind the cat. (3) Using the same artwork for the cat but applying different wave-forms, pivoting some of the parts, and adjusting the vertical and horizonal size produces an angry-looking cat. (4) The cat "does a take." Horizontal size is changed on most of the parts, and a high-frequency delta wave is applied to the tail.

puter animation, and led to the development of SCANIMATE. SCANIMATE computer animation is now a familiar sight to television viewers, although they may not be aware that the images they are watching are computer-produced. SCANIMATE does only limited character animation; its principal use is in plasticizing and metamorphizing images. But SCANIMATE led to CAESAR, and CAESAR does full character animation.

CAESAR and SCANIMATE are unique among the many designs of animating computers in that they are basically analog devices rather than digital. With a digital system the plotting and programming of a key frame may require days of calculation. Then to animate the sequence the digitally-generated display might require several seconds to "paint" each frame on the CRT from which it is recorded. Because the analog system is faster, it usually takes an experienced animator working with CAESAR longer to plan a storyboard than it does to animate the film.

What does the finished animation look like? It looks very much like conventional film animation, although most of the drudgery associated with the production of animation has been eliminated, so perhaps the animator is freer to be creative. The quality of the image is good since it is displayed on a high-resolution, 945-line color television screen. The handling of characters is not yet equal to the best of Disney Studios, but it far surpasses that which is seen on Saturday morning TV.

Once you understand some of the basic processes of the system and know its capabilities, CAESAR's creative possibilities are apparent. At its most elementary level, CAESAR's operation is the re-shaping of a television raster, the white square which is displayed on the face of a cathode ray tube. By applying the proper electronic signals to the raster it is possible to cause it to bend, squash, stretch, turn, or grow larger or smaller. If a cartoon figure is displayed within this raster, he will also bend, squash, etc. For example, if a delta



(5) The animator usually needs to make only a few pencil sketches of the character showing him in typical poses. (6) The sketch of the character is rendered as a high-contrast negative, with each of the parts distributed separately. Additional parts may be included, for example several heads to simplify major changes of position or expression.

wave is applied to the side of the raster, it will bend and the figure displayed on it will appear to bow. And CAESAR will remember that bend and will play it back to you. But this is only the beginning.

Now imagine that the raster is divided into seven sections, as if there were seven vertical rasters. Each of the seven may be controlled independently. Now picture the cartoon character broken up into seven parts, like cutting up a paper doll, and each part displayed within a separate raster. The head is in the first raster, an arm in the second, the body in the third, and so forth. Since the rasters can be individually controlled, the animator looks at this array of head, arms, etc., on the screen and by manipulating the controls positions all of the pieces until they are assembled correctly and are in position for his first frame of animation. He then "stores" this frame in CAESAR's memory and "advances in time" to a later instant in the ongoing action and manipulates the character into the position which he will assume in this second "key frame." In the conventional animation it is the production of the many pieces of artwork necessary to connect the key frames which is most time-consuming—but CAESAR does this in seconds!

Here is how a typical sequence might be animated: Say that the action is to be a "Run cycle," a fast realistic run with the character's foot hitting the ground every third of a second. Since CAESAR calculates in video scanning rate, rather than movie sound speed, there are thirty frames per second. The animator instructs CAESAR to copy the character from frame one into frames ten and twenty. This will close the animation cycle. He then asks for frame ten to be displayed and alters the position of the character's arms and legs so they are correctly positioned for the middle stop of the run. Appropriate "squash and stretch" to add bounce to the run are set with "horizonal size" and "vertical size" controls. When the animator is satisfied with the appearance of the character in its key positions, he presses a button which tells CAESAR to animate the sequence. CAESAR provides all of the animation between the key frames, with accelerations and decelerations or any combination thereof as desired, and plays back the results in the time it takes to scan the magnetic memory.

CAESAR would be equally obliging if instructed to make the character move in apparent depth, fly through the air, change colors, disappear behind objects on a painted background, or conduct lip-sync dialog with a live actor. It could do all of these things simultaneously if the script required it. And since the actions are recorded in a magnetic memory, it is relatively simple to re-play the scene or any part of it and make additions or corrections of the action or timing as desired.

With conventional animation it is usually necessary to prepare hundreds upon hundreds of drawings which must be inked onto acetate cels and painted by hand to produce the film. With CAESAR, the artist's task is relatively simple. It is usually necessary to produce only a few pencil sketches of the character illustrating full-face, profile, and three-quarter view. These drawings are broken down into their various parts and are rendered as high-contrast negatives. The negatives are keyed for color using transparent grey overlays, and are input to CAESAR through a TV system. Backgrounds may consist of paintings, photographs, models, full-scale three-dimensional objects, or virtually anything which can be displayed in front of a color television camera.

There are of course limitations to the present system. If additional characters are required, it is usually necessary to animate them separately and record them on videotape in successive passes. Rotation of characters requires additional artwork. Real-time inputs are possible, but are not the usual mode of operation. Direct film recording is also possible, but videotape is recommended, with later transfer to film if required.

Animation has been losing ground in recent years as the cost of handwork and drudgery has steadily risen. Studios have gone to Xerox "inking" or other photomechanical processes. Disney has gone to live-action films for its bread-and-butter. Hanna-Barbera continues with limited animation. And the Japanese studios dread the day that animators' wages go up. TV animation has succumbed to time and cost pressures to the extent that animators who work for TV call their shops "sausage factories," because every episode of every show looks like every other.

CAESAR could be turned into a "sausage machine," but this would be an unfortunate waste of potential. No creative animator desires that his work emerge as a bland stereotype, but too often he is caught in the middle, having to simplify his ideas and make artistic compromises just to stay on board the treadmill. It is to be hoped that CAESAR's facility in handling the routine, mechanical elements of the animation process will free the animator and encourage him to further explore the human, creative aspects of animation.

Until now the existence of CAESAR has been generally unknown to animators. SCANIMATE has been Computer Image's stock-in-trade, while CAESAR's development has received virtually no publicity. Computer Image is now extending its operations from its Denver home-office to form Image West in Los Angeles. CAESAR is about to land as a bombshell on the world of commercial cartoon animation, and the impact will produce profound changes both in its economics and in its consideration of this art.

CAESAR has been, in a way, like the flea on an elephant. For the flea, that elephant was the whole world. Then one day he realized he had the whole world by the scruff of the neck . . . but the world didn't know it yet . . .

(7) To animate a simple "run cycle" the animator merely manipulates the controls to establish the position of the character for frame One and frame Ten (frame Twenty is identical to frame One), then CAESAR animates the "In-between" eighteen frames. To extend the scene the cycle can be copied automatically as many times as required. The "squash and stretch" are added by use of the vertical and horizonal controls. Acceleration and deceleration are computed and incorporated automatically if desired.

GLOSSARY

PLEASE READ these definitions of motion picture trade jargon and abbreviations, many of which are used in this script.

PICTURE

ANIM - animation: Art work, not live.
BG - background: Area in camera's view farthest from camera.
CU - close-up: Close view of subject, e.g. man's head.
CUT - abrupt, instantaneous scene change.
DISS - dissolve: Smooth gradual scene change. One scene disappears while simultaneously, another appears.
DOLLY - in live action, camera movement by physically moving camera while photographing.
ECU - extreme close-up: Extreme close view of subject, e.g. man's eye.
ELS - extreme long-shot: Extreme long view of subject, e.g. whole man a speck in the desert.
EXT - exterior: Scene shot outside in natural weather conditions.
FG - foreground: Area in camera's view nearest to camera.
FI - fade in: Scene gradually appears out of blackness.
FO - fade out: Scene gradually disappears into blackness.
INT - interior: Scene shot indoors.
LA - live action: Live, real subjects.
LS - long-shot: Long distance view of subject, e.g. man, head to foot.
MCU - medium close-up: Medium close view of subject, e.g. head and shoulders.
MLS - medium long-shot: Medium long view of subject, e.g. knees to head.
MONTAGE - series of shots conveying a "feel" for the subject, not an explanation.
MS - medium shot: Medium distance view of subject, e.g. waist to head.
OS - over-shoulder: Camera looking over shoulder, past ear of a subject.
PAN - camera movement from side to side.
POP - an element appears or disappears instantaneously, others in the camera view remain constant.
POV - point-of-view: Defines what camera or actor is seeing.

SOUND

BG - background: Low volume sounds "behind" the significant sound.
FX - effects: Sound effects to enhance or clarify picture.
LS - lip-sync: Sound recorded simultaneously with picture photography so that on-screen lips synchronize.
MX - music: Music to complement picture.
SEGUE - (seg'way) smooth gradual sound change, equivalent to picture DISS.
WILD - not synchronized: Sound recorded at a time or place different from the matching picture photography.

Note: Information in (CAPS AND PARENTHESES) is not to be recorded, but is info explaining the sounds to be part of the final film.

PICTURE (CONTINUED)

RP - rear-projection: Previously photographed scene projected from the rear on a translucent screen for re-photography by a camera in front.
STOCK - stock footage: Existing film available for use in this script.
SUPER - title superimposed on the BG.
SWISH PAN - very fast pan so that objects blur and "swish" past.
TILT - camera movement up or down.
TRUCK - in animation, camera movement by physically moving camera while photographing.
VIGNETTE - object of interest fully exposed in a puddle of light, rest of frame slightly underexposed.
ZOOM - camera movement by optically moving subject with a "zoom" lens.
2 SHOT, 3 SHOT, ETC. - subjects sharing the frame with equal prominence.

Note: Camera distance CU, MS, LS, etc. is relative to subject, e.g. LS man is whole man. LS football stadium is whole football stadium.

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CAESAR TECH WORKSHEET | CLIENT/JOB | SCENE | PAGE OF

ACTION			FRAME COUNT		ACTION STARTS (DELAY COUNT)	ACTION DURATION		ACTION STOPS	'MASTER ANIMATION' IN SCENE X		INSERT FROME SCENE X		INTO SCENE Y STARTING AFTER FRAME	NO. OF TIMES TO INSERT	SCENE Y WILL HAVE FRAMES
WHICH PASS ?	EVENT NO.	WHAT HAPPENS	SOUND SPEED 24 FPS	VIDEO RATES 30 FPS		SOUND SPEED	VIDEO RATES		START	STOP	FRAME	TO FRAME			

6/15/76

CH SCENE | FAIR ALL PARAM | SPECIAL AXIS ROTATION | NO FUNCTION

INPUT CHANNELS

GRD

1 2 3 4 5 6

REMOTE

NORMAL

FRAME

SECTION

ANIMATION OSC

PHASE LOCK — FREQUENCY

RANGE

SECTION LENGTH ~~COARSE~~ | ←DITTO MEDIUM | ~~FINE~~

OSCILLATOR

HORIZ | VERT | DEPTH

SINE △ ◿ ⊓

WAVEFORM

VIDEO SOURCE

UP/DOWN | LEFT/RIGHT | WHICH CAMERA BOX

SPECIAL BLANKING | OVERLAP | NOTHING

DISPLAY ARTWORK

COLOR

OFF | 1 | 2

3 4 5 6

HOLD ~~SCENE~~ | UPDATE TAP TIMER/INSERT ~~SECTION~~S | TRANSFER PERAMETER KEY ~~SECTION~~

EDIT

COPY FRAMES | DELETE FRAMES | RECALL ~~INSERT~~ FRAMES

LINEAR FAIRING AND BLANKING | FAIRING ACCELERATE | DECELERATE | ACC-DE

ABORT

KEEP IT

(D) DISPLAY ROTATION POINTS (UP POSITION)

ANIMATION

1

SELECT

V Pos | H Pos | V Axis | H Axis | AO Amp | ~~AO Freq~~ | ~~AO Phase~~ | Sect Lgth

OFF | ~~ROTATION~~ | V Size | H SIZE | ~~DEPTH~~ | SEC BLANK START | S.B. WIDTH | ~~V Limb~~ | INTENSITY ~~H Limb~~

INDIV. V POS H. POS

2

SELECT

V Pos | H Pos | V Axis | H Axis | AO Amp | AO Freq | AO Phase | Sect Lgth

SAME AS #1

OFF | V Size | H Size | Depth | Rotation | Intensity | V Limb | H Limb

3

SELECT

V Pos | H Pos | V Axis | H Axis | AO Amp | AO Freq | AO Phase | ~~Sect Lgth~~

SAME AS #1 EXCEPT FOR ↙ OSC FREQ

OFF | V Size | H Size | Depth | Rotation | Intensity | V Limb | H Limb

RECENTER

OPERATE

RESOLUTION — 1 FINE

CONTROL

RESOLUTION — 1 FINE

CONTROL

RESOLUTION — 1 FINE

CONTROL

ANIMATE

PLAYBACK ENABLE

SLOW MOTION

~~SINGLE FRAME~~ NON FUNCTIONAL

~~START~~ STOP | ~~STOP~~ GO

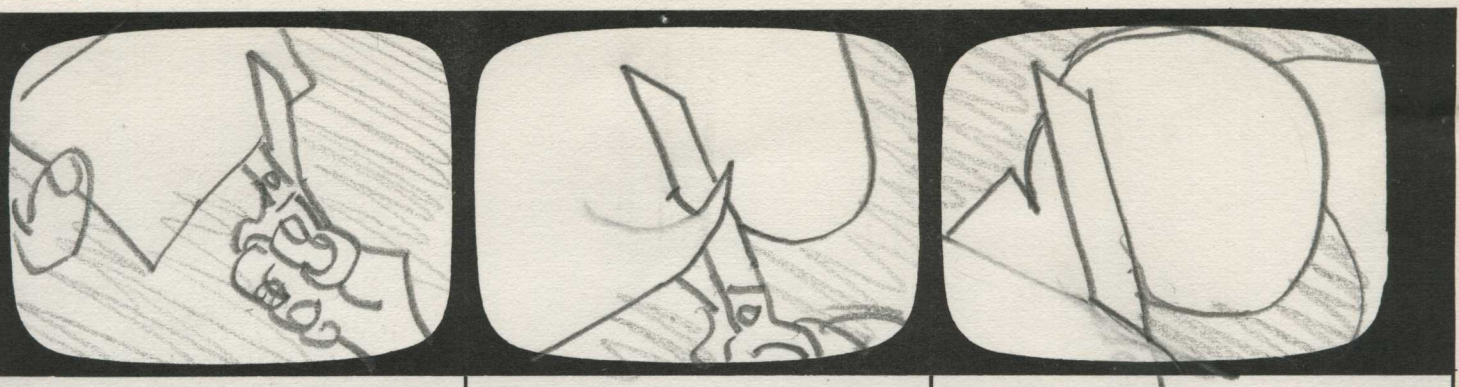
YES

NO AND STOP TAP TIME

TAP TIME START

FINAL FRAME TAP TIME

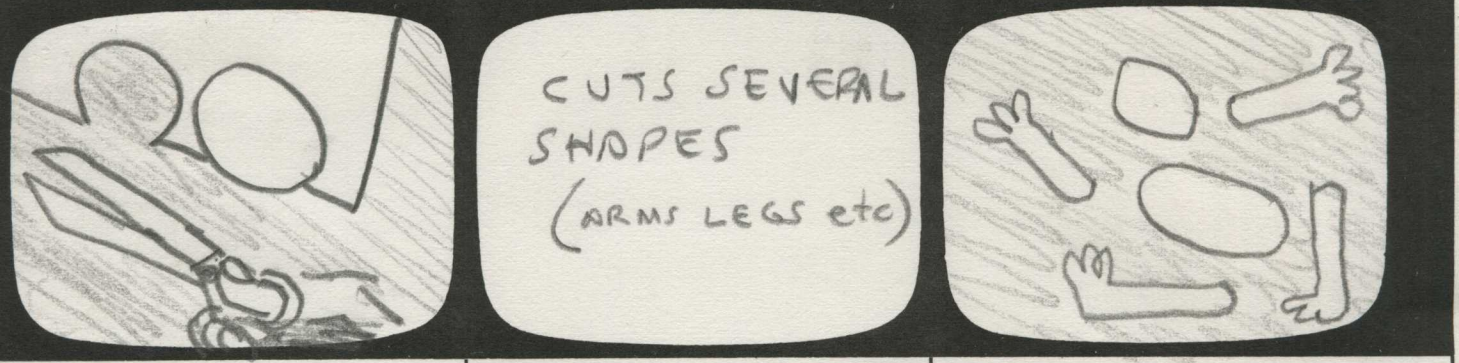
REMOTE START

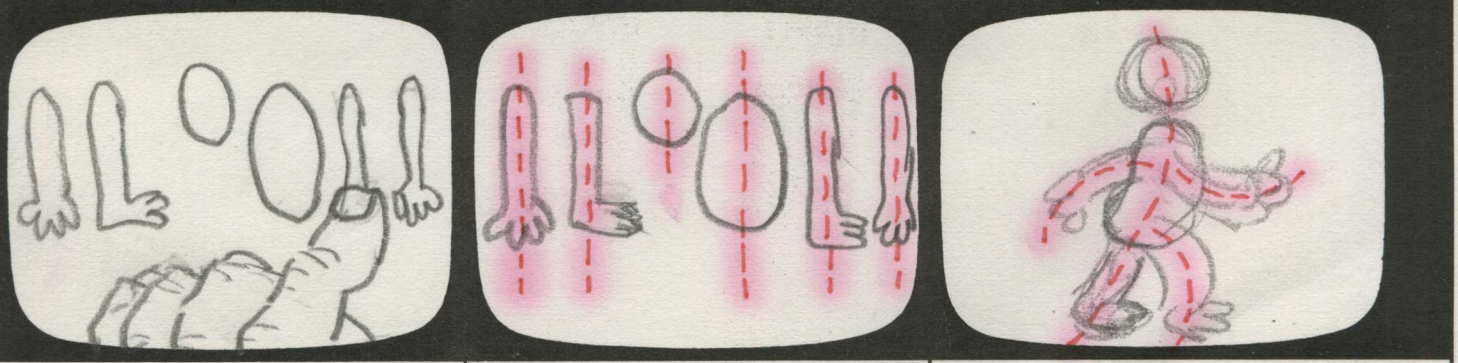


SUPPOSE, INSTEAD OF FANCY ARTWORK WE SUBSTITUTE SIMPLE PAPER CUT OUTS...

WE MAKE...

A HEAD





PIECES ARRANGED IN CAESAR ORDER

DOTTED LINES APPEAR

LEAD TECHNICAL AIR TO PORTRAYAL!

PIECES ARE ANIMATED

THIS STORYBOARD IS THE PROPERTY OF

COMPUTER IMAGE CORPORATION
2475 West 2nd Avenue, Denver, Colorado 80223
(303) 934-5801

1 HEADS

2 CHEST

3 HIPS

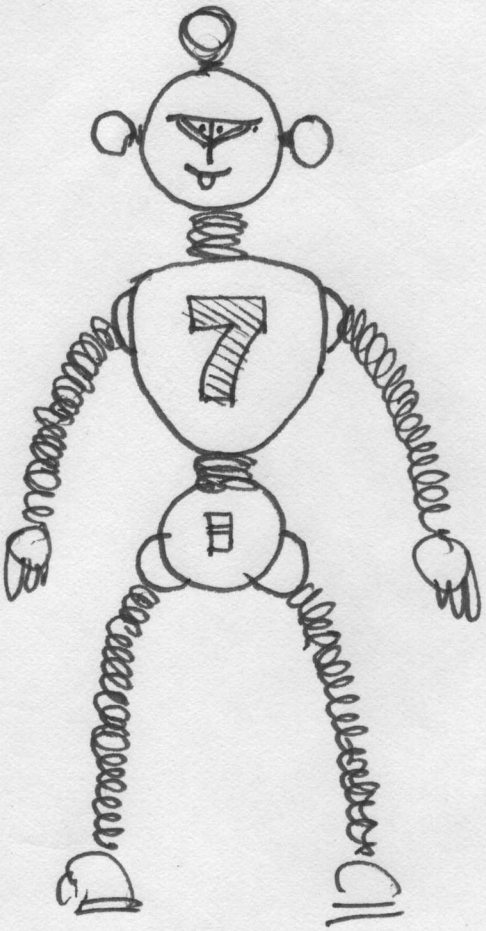
4

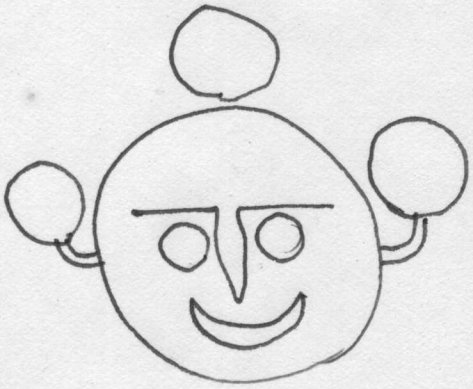
5

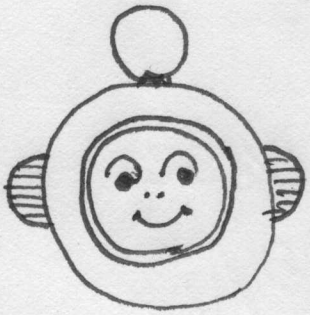
6

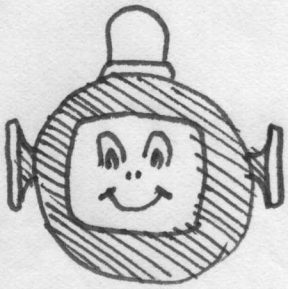
7

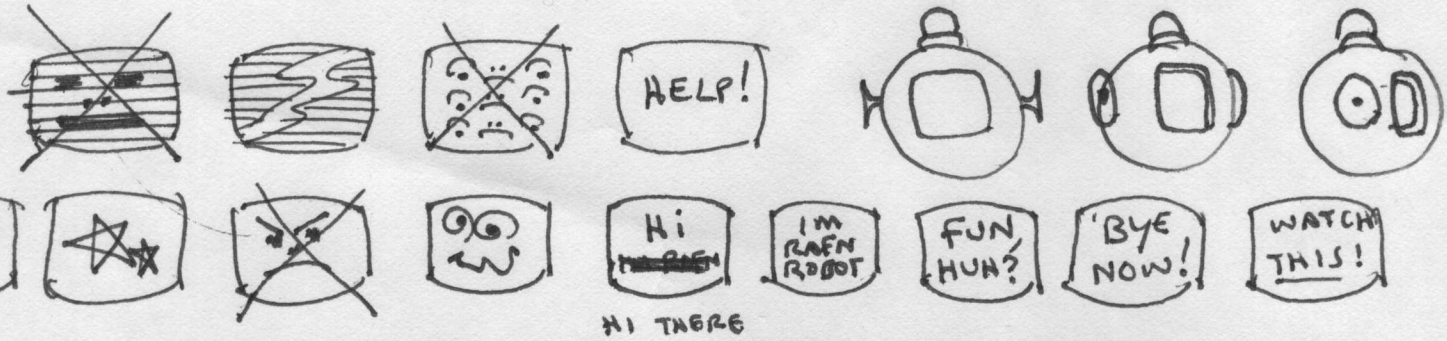
8 FACES



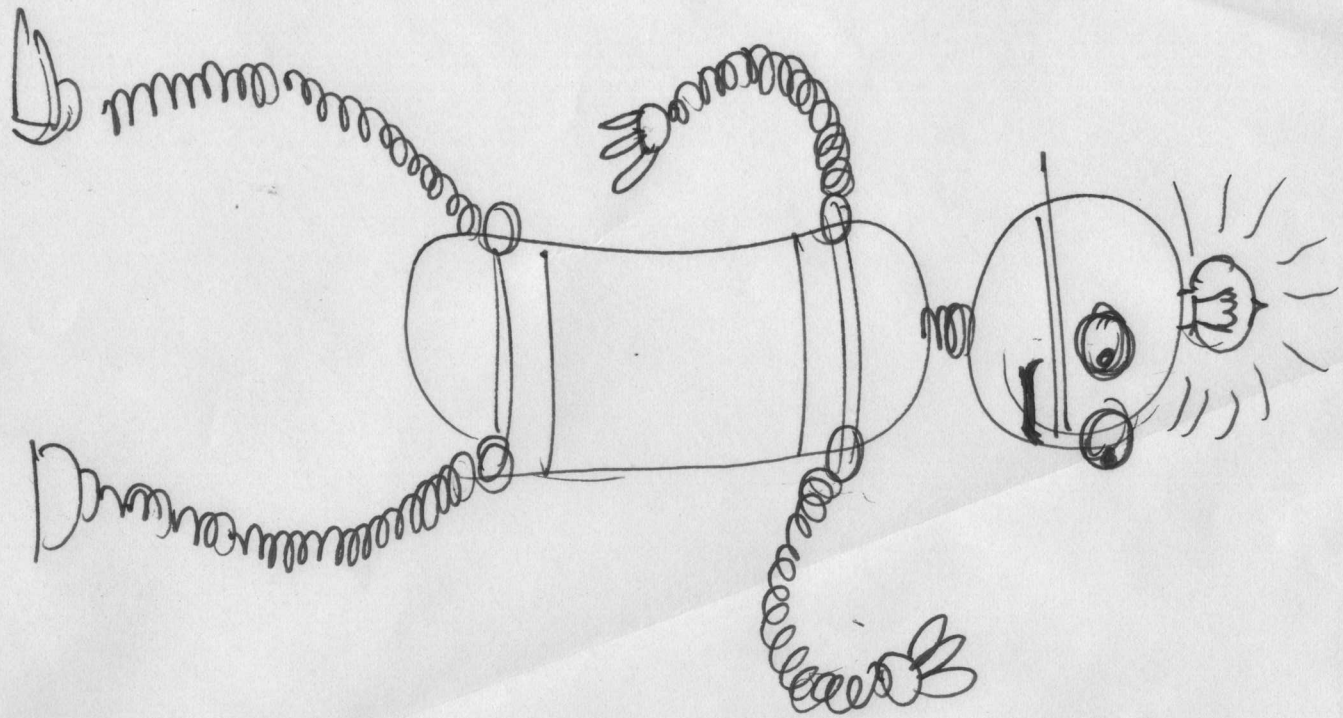


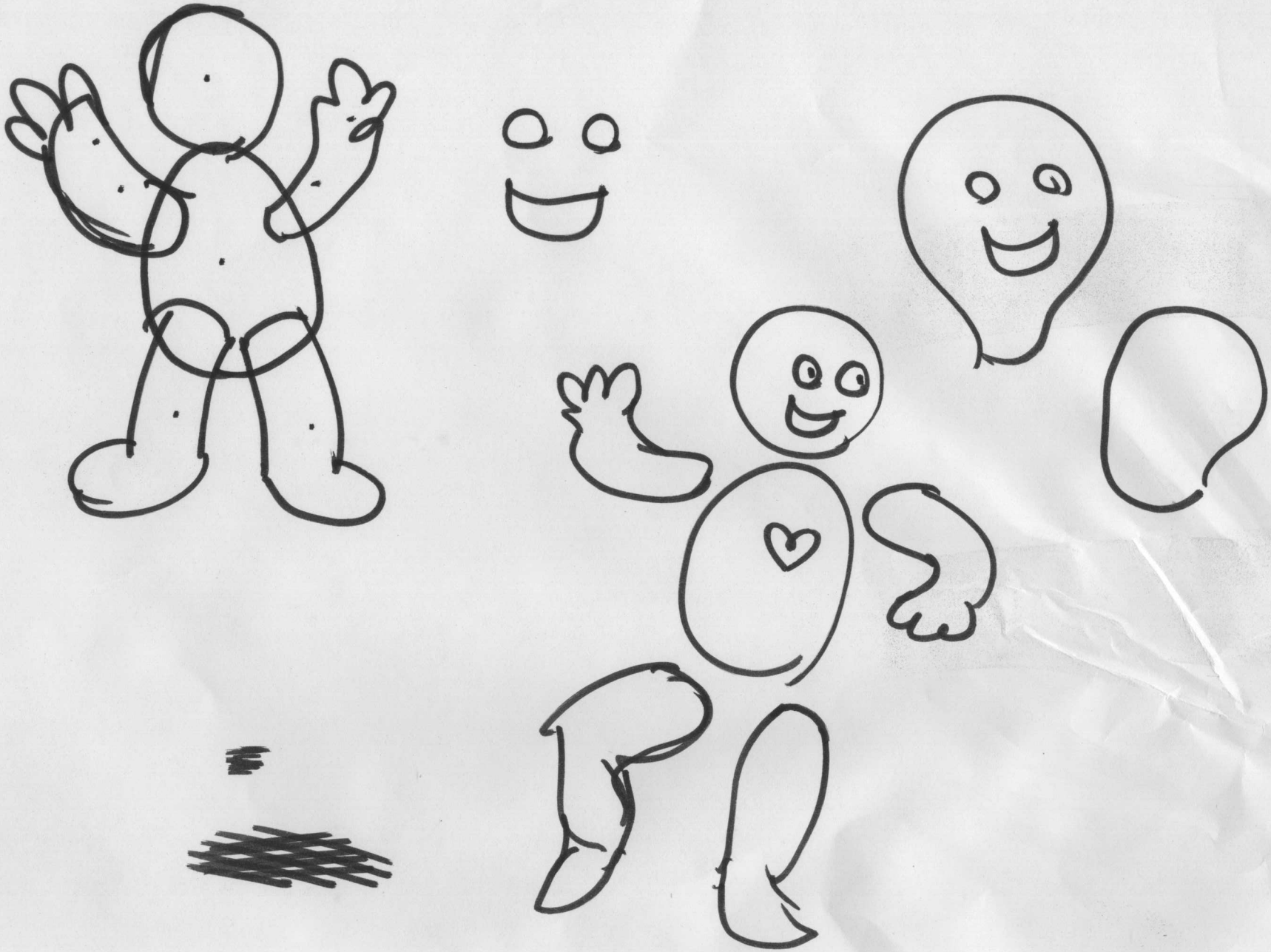




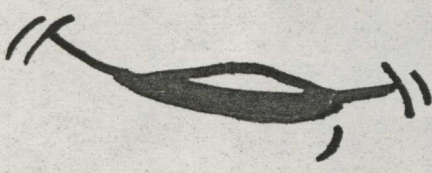


HI THERE





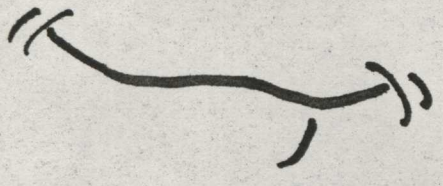
LIPSYNC CHART



A. MOST "F" CONSONANTS

B. "EEE" TRANSITION

C. OPEN MOUTH VOWELS (HA)



D. M, B, P... SMILE

E. "AW" & TRANS. TO F. MOUTH

F. "O" "U"

K&M Company
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D311 1